Clifton Scannell Emerson Associates

Kilkenny Northern Ring Road Extension – (Freshford Road to Castlecomer Road)

Environmental Impact Statement Volume 2 – Main Report

Kilkenny County Council

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PREFACE

THIS ENVIRONMENTAL IMPACT STATEMENT CONSISTS OF THE FOLLOWING FOUR DOCUMENTS:

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ABBREVIATIONS AND DEFINITIONS

The following abbreviations and definitions are used in this document:

%	Percentage
%ile	Percentile
AA	Appropriate Assessment
AADT	Annual Average Daily Traffic
Ac	assimilative capacity
AFF	An Foras Forbartha
AG	Aghmacart Formation
Al	Aluminium
AQS	Air Quality Standard
Arcady	Assessment of Roundabout Capacity and Delay (software package)
As	Arsenic
ASI	Area of Scientific Interest
AWN	AWN Consulting (Specialist Environmental Consultants)
B	Boron
BA	Ballysteen Formation
BCR	Benefit to Cost Ratio
BOD	Biochemical Oxygen Demand
BRE	Building Research Establishment
BS	British Standard
°C	Degrees Celsius
c.	circa
Carriageway	That part of a road designated for travelling vehicles.
CEC	Council of the European Communities
CFB	Central Fisheries Board
CGI	Computer Generated Images
Ch.	Chainage
Chainage	The length in metres from the start of the scheme.
CIRIA	Construction Industry Research and Information Association
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COBA	Cost Benefit Analysis
COD	Chemical Oxygen Demand or Chamber of Deputies
CPO	Compulsory Purchase Order
CRTN	Calculation of Road Traffic Noise

CSEA	Clifton Scannell Emerson Associates (Consulting Engineers)
CSO	Central Statistics Office
Cul-de-sac	A road which stops at a dead-end.
Cutting	A section of a road which is below the original ground level.
dB	Decibel
dB(A)	A-weighted decibels (Noise Measurement)
dB, L_{den}	Noise indicator: long term sound level in decibels (24-hour value)
DEFRA	UK Department for Environment, Food and Rural Affairs
Design Speed	The speed for which a road has been designed in accordance with the DMRB.
DM	Do Minimum
DMRB	The Design Manual for Roads and Bridges, issued by the National Roads Authority.
DO	Dissolved Oxygen
DoEHLG	Department of the Environment, Heritage and Local Government
Do Minimum	A scenario where no major improvement works are carried out on the road network.
Do Something	A scenario where the proposed Scheme is constructed.
DS	Do something
DWF	Dry Weather Flow
EC	European Community
EEC	European Economic Community
EIS	Environmental Impact Statement
Embankment	A section of road which is above the original ground level.
EOP	Environmental Operating Plan
EPA	Environmental Protection Agency
Eqn	Equation
ESRI	Economic and Social Research Institute
EU	European Union
Fill	Material used to raise a road above the original ground level.
GHG	Greenhouse Gases
GSI	Geological Survey of Ireland
ISO	International Organisation for Standardisation
ha	Hectare
HGV	Heavy Goods Vehicle
Horizontal Alignment	The direction or course of a road in plan.
HSE	Health Services Executive
Hz	Hertz

IFI	Inland Fisheries Ireland
KCAN	Kilkenny Community Action Network
KCAS	Kilkenny Central Access Scheme
KCTM	Kilkenny City Traffic Model
km	Kilometre
kph	Kilometre per hour
kV	Kilovolt
Landtake	The land required for construction of the road.
LAP	Local Area Plan
LAQM	Local Air Quality Management
m	Metre
m^2	Square Metre
m^3	Cubic Metre
mAOD	Metres Above Ordnance Datum (Poolbeg)
mbgl	Metres below ground level
mm	Millimetres
mg	Milligram
mg/l	Milligrams per litre
$MtCO_2$/year	Million Tonnes of Carbon Dioxide per Year
Mtonnes	Million Tonnes
N	Nitrogen
N/A	Not Applicable
NDP	National Development Plan
NH_3	Ammonia (gaseous)
NH_4	Ammonia (aqueous)
NHA	Natural Heritage Area (prefix ‘p’ indicates proposed)
NIAH	National Inventory of Architectural Heritage
NIS	Natura Impact Statement
NMP	Noise Monitoring Point
NO_2	Nitrogen Dioxide (in the atmosphere, Nitrite (in water)
NO_3	Nitrate
NO_x	Nitrogen Oxides
NPV	Net Present Value
NPWS	National Parks and Wildlife Service
NR	Noise Receptor
NRA	National Roads Authority
NSS	National Spatial Strategy
OPW	Office of Public Works

p.a.	per annum
PM	Particulate Matter
PO_4	Orthophosphate
pp.	Page
PPV	Peak Particle Velocity
PVB	Present Value of Benefits
PVC	Present Value of Costs
RIAI	Royal Institute of Architects in Ireland
RMP	Record of Monuments and Places
RPG	Regional Planning Guidelines
RSPB	Royal Society for the Protection of Birds
s	Second
SAC	Special Area of Conservation (under EU Habitats Directive – prefix 'c' indicates candidate
Services	Cables, pipes, plant or equipment carrying water, telephone, sewage, etc.
S.I.	Statutory Instrument
SPA	Special Protection Area (for the Conservation of Wildbirds)
Sp.	Species
Sq. M	Square Metre
SRFB	Southern Regional Fisheries Board
TG	Technical Guidance
TPO	Tree Preservation Orders
TRL	Transport Research Laboratory
UNFCCC	United Nations Framework Convention on Climate Change
UTC	Coordinated Universal Time
Vertical Alignment	The direction or course of a road profile.
WQS	Water Quality Standard
$\mu g/m^3$	Micrograms per Cubic Metre
µS/cm	Microsiemens per Centimetre

1.0 INTRODUCTION

1.1 Brief

Clifton Scannell Emerson Associates Consulting Engineers (CSEA) was commissioned by Kilkenny County Council to prepare an Environmental Impact Statement (EIS) for the proposed Kilkenny Northern Ring Road Extension – (Freshford Road to Castlecomer Road scheme. This road development runs between an existing roundabout junction between the existing N77 Kilkenny Ring Road Extension and N77 Castlecomer Road, and a proposed roundabout on the R693 Freshford Road, with a bridge crossing of the River Nore (Figure 1.01 and 1.02).

This EIS was compiled on completion of a Constraints and Route Option Study on the proposed road development, which can be found in Appendix A.

1.2 Legislation

This EIS has been prepared in accordance with the requirements of Section 50 of the Roads Act 1993-2007, and amendments thereto conferred by the Planning Acts, 2000-2009 and other enabling legislation including Section 217(B)(4)(b) of the Planning and Development Act, 2000 as inserted by the Planning and Development (Strategic Infrastructure) Act, 2006.

This EIS is being submitted to An Bord Pleanála under Section 217(B)(4)(b) of the Planning and Development Act, 2000.

1.3 Scope and Structure of the EIS

The following elements of the receiving environment and their interactions are described within the EIS:

- Human Beings;
- Flora and Fauna;
- Hydrology;
- Soils, Geology and Hydrogeology;
- Air Quality and Climate;
- Noise and Vibration;
- Landscape and Visual;
- Cultural Heritage; and,
- Material Assets.

1.3.1 Structure of the EIS

The EIS consists of the following four volumes:

Volume 1 – Non Technical Summary

This Volume contains an overview of the Scheme and the principal findings of the environmental assessment in non-technical language.

Volume 2 – Main Report

This Volume contains the main text of the EIS. Chapters 1 - 5 provide an introduction to the Scheme, discuss the alternatives considered, established the need for the Scheme, and describe the altered Scheme and the traffic assessment.

Chapters 6 – 14 consist of specialist Chapters setting out the environmental assessment of the effects and impacts of the Scheme on each environmental attribute. Chapter 15 summarises the schedule of environmental commitments as part of the Scheme, which is being submitted to An Bord Pleanála for Approval.

Volume 3 – Figures

This Volume contains drawings to accompany the main text of the EIS.

Volume 4 – Appendices

This Volume contains additional information relevant to each specialist Chapter where necessary.

Each of the specialist environmental Chapters (Chapter 6 – 13) is set out as follows:

- A brief **Introduction** to the Chapter;
- An outline of the **Methodology** employed in undertaking the specialist assessment;
- A description of the receiving **Existing Environment** relevant to the environmental topic under consideration;
- A description of the **Characteristics and Predicted Effects/Impacts of the Proposed Development** in the receiving environment;
- A description of the reductive or **Mitigation Measures and/or Factors** that reduce or eliminate any significant adverse environmental impacts identified;
- A description of **Residual Impact** of the proposed development. Residual impacts are the remaining impacts that will occur after the proposed mitigation measures have taken effect;
- A description of Interactions with other **Environmental Attributes**;
- Details of any **Monitoring** required;
- Details of any **Reinstatement** required; and,
- **Difficulties Encountered** in undertaking the assessment.

1.4 EIS Methodology

Where appropriate in preparing this EIS, reference was made to best practice guidelines including the following:

- National Roads Project Management Guidelines, National Roads Authority (NRA), March 2000;
- Guidelines on the Information to be Contained in Environmental Impact Statements, Environmental Protection Agency (EPA), 2002;
- Design Manual for Roads and Bridges – Volume 11, Environmental Assessment;
- Environmental Impact Assessment of National Road Schemes – A Practical Guide, NRA, Revision 1, 2008; and,
- Environmental Assessment and Construction Guidelines, NRA, Various Publications.

1.5 Non Statutory Consultation

Non Statutory Consultations have been an integral component throughout the design and environmental impact assessment processes in order to inform and refine the Scheme. These consultations sought the views of statutory consultees, Elected Members and the affected landowners.

These consultations have taken place as follows:

1. January 2008 to March 2012 – as part of the preparation of the Constraints and Route Option Study submitted to Kilkenny County Council in March 2012.
2. June 2012 to November 2013 – as part of the preparation of the EIS.

1.5.1 Consultation with An Bord Pleanala

Following preparation of the Constraints and Route Options Study, An Bord Pleanala were consulted. Their recommendations aided the screening of this EIS, and can be found in Appendix B.

1.5.2 Consultation with Relevant Stakeholders

In February 2013 a consultation letter was issued to a number of stakeholders. The letter invited the stakeholders to provide comment on the design of the scheme. The letter was issued to the following consultees:

- Geological Survey of Ireland & Geological Heritage (GSI);
- Department of Environment, Heritage & Local Government (DoEHLG);
- Environmental Protection Agency (EPA);
- Office of Public Works (OPW) Hydrometric section;
- National Parks and Wildlife Services (NPWS);
- Inland Fisheries Ireland (IFI);
- Irish Peatland Conservation Council (IPPC);
- National Roads Authority (NRA);
- An Taisce;

- Heritage Council.

Responses were received from the OPW, NRA, EPA, GSI, An Taisce, Heritage Council, IFI and NPWS. Responses can be found in Appendix C.

A number of meetings were also held with stakeholders as part of the preparation of this EIS as follows:

- Meetings between representatives of the National Parks and Wildlife Service (NPWS) of the DoEHLG and CSEA were held at various stages of the Constraints and Route Options Study.
- Meetings between representatives of the National Parks and Wildlife Service (NPWS) of the DoEHLG and Roger Goodwillie, Ecology Consultant, during the preparation of the EIS.
- Meetings between representatives of the Office of Public Works (OPW) and CSEA were held at various stages of the Constraints and Route Options Study and during the preparation of the EIS.

1.5.3 Consultation with Elected Members

The Scheme has been presented to the Elected Members at various stages of the Constraints and Route Options Study and EIS preparation.

These consultations have taken place as follows:

1. 5th March 2012 – to present the Constraints and Route Option Study.
2. 26th April 2013 – as update the members on the EIS progress.
3. 21st June 2013 – presentation of the draft EIS. The Elected Members unanimously approved that the EIS and CPO be submitted to An Bord Pleanála.

1.5.4 Consultation with Affected Landowners

As part of the EIS process, representatives of Kilkenny County Council and the design team have held a number of meetings with affected landowners.

These consultations have taken place as follows:

1. January 2008 – September 2013 – several meetings with the three main landowners.
2. September 19th 2013 – a public meeting with the residents of the Bleach Road.
3. October 10th 2013 - a public meeting with the residents of the Bleach Road.

1.6 Project Team

CSEA undertook the preparation of the EIS with the following consultants:

- Roger Goodwillie - Ecology, incl. Terrestrial Flora Assessment and Natura Impact Statement;
- Aardwolf Wildlife Surveys - Terrestrial Fauna Assessment;
- Courtney Deery Ltd - Archaeological and Cultural Heritage Assessment;

- AWN Consulting - Soils, Geology and Hydrogeology Assessment;
- AWN Consulting - Air Quality Modelling and Assessment;
- AWN Consulting - Noise and Vibration Modelling and Assessment;
- Steer Davies Gleeve - Traffic Modelling; and,
- John O'Sullivan, University College Dublin - Hydrology Assessment.

2.0 NEED FOR THE PROPOSED DEVELOPMENT

2.1 Deficiencies with the Existing Road Network

Kilkenny City Centre retains much of its historic character and the street network largely reflects this historic appeal. Carriageway and footway widths vary markedly and are generally less than is considered desirable for streets carrying two-way through traffic. As a result many of the streets are unsuitable for the volume and types of traffic they currently carry.

The main traffic flows into the City Centre converge at the existing bridges, Green's Bridge and John's Bridge, both of which are already operating over capacity at peak times.

Green's Bridge is a multiple arch stone bridge dating back to the 18th Century. It carries an approximately 5 metre wide road, and was modified in 1969 to incorporate a 1.5 metre footway cantilevered from the north side, which does not provide the desirable minimum width for pedestrians. Green's Bridge crosses the River Nore perpendicularly on a crest curve that limits forward visibility. At its eastern end there is a crossroads with Greensbridge Street and Green's Hill Street, which has particularly poor visibility for vehicles emerging from these streets. On the west side of Green's Bridge traffic flow between Green's Bridge and Dean Street is impeded by the narrowness of Vicar Street, which is only 4.5 metres wide at its narrowest point (too narrow for two trucks to pass), and has substandard footways.

John's Bridge, which was constructed in 1910, is wider than Green's Bridge. It is built of reinforced concrete in a single span that is approximately perpendicular to the line of the River Nore. The carriageway on John's Bridge is 6.6 metres wide, with a 1.5 metre footway on each side. However, the approach from John Street is narrower, with a slight bend just east of John's Bridge. The carriageway narrows at this location to 5.4 metres in width. Traffic is further impeded by junctions with Bateman's Quay and John's Quay at the ends of the bridge.

HGVs and other through traffic travelling from the N78, N10, or N77 must use the city streets, including the city centre bridge crossings, to reach the R693, leading to the M8 and further west.

2. 2 Objectives of the Proposed Development

The objectives of the scheme are to:

- **Reduce congestion in the City Centre and Green's Bridge.** This Scheme will reduce through traffic alleviating congestion in the City Centre and on Green's Bridge. It will also facilitate the implementation of traffic management measures, including proposed HGV bans on appropriate routes throughout the City. Both Green's Bridge and John's Bridge have inadequate capacity and cannot adequately cater for multi-modal traffic. The traffic congestion

currently experienced on the existing bridges acts as a constraint to travel between the east and west sides of the City Centre. Table 2.1 below shows the daily traffic flows crossing the River Nore bridges with and without the proposed Scheme. This shows the levels of traffic removed from the City Centre by the proposed Scheme. These figures are projected for the year of opening 2019 and the design year 2034, and assuming the Central Access Scheme is completed by 2019. Figure 2.01 shows these traffic projections graphically.

Table 2.1 – Traffic Flows Crossing River Nore

AADT Flows				
Location	**2019**		**2034**	
	Without Scheme	**With Scheme**	**Without Scheme**	**With Scheme**
Proposed Scheme	-	7705	-	15925
John's Bridge	7049	6988	15814	14424
Central Access Scheme	10388	7350	21541	15925
Green's Bridge	11956	9383	17854	12734
N10 Ring Road Bridge	27900	28160	28790	27970
Totals	**57293**	**59586**	**83999**	**86978**

- **Complement the proposed Central Access Scheme.** The traffic modelling undertaken in support of this EIS clearly demonstrates that the Scheme will compliment the Central Access Scheme in alleviating traffic congestion in Kilkenny City.
- **Provide an extension to the N77 Ring Road connecting the Freshford Road and the Northwest of the City to the existing Ring Road.** The Scheme will greatly improve access to the city from the northwest. The River Nore currently represents a physical obstacle between the northwest of the city and the extensive housing and other development to the east of the city centre. Congestion on John's Bridge and Green's Bridge reduces movement between parts of the city to the east and west of the River Nore. The Scheme will facilitate improved permeability for all modes of transport.
- **Strategic Road Network for the region, connecting the M9 to the M8 via the Kilkenny Ring Road.** The Scheme provides a reliable, safe and efficient link between the M9 and the east and south-east of the country and the M8 at Urlingford and the north and north west of the country.
- **Facilitate the promotion of walking and cycling.** The Scheme includes the provision for cyclists and pedestrians in a safe environment. By reducing traffic levels in the City Centre, it will also facilitate other actions to promote sustainable modes of transport, including pedestrianisation measures as envisaged in the Kilkenny City Centre Local Area Plan.
- **Improve traffic safety and convenience.** The Scheme will be designed to a 100kph design speed, and will create a safe and convenient environment for vehicle, cycle and pedestrian

movement, including the segregation of modes and other measures. The Scheme will reduce travel times for local and through traffic.

2. 3 Policy Need for the Proposed Development

This section outlines the policies, plans and reports which are relevant to the proposed Scheme.

2.3.1 National Spatial Strategy 2002-2020, and the National Development Plan 2007-2013

The National Spatial Strategy (NSS), 2002-2020, sets out a twenty-year planning framework for Ireland with the aim of strengthening economic and social functions for strong and sustainable progress. Within the NSS, Kilkenny City is designated a 'Regional Hub', with national road converging in Kilkenny from Cork, Waterford, and Dublin. A 'Hub' is defined in the NSS as an area into which future development will be directed and facilitated. Together with Waterford and Wexford, Kilkenny forms a nationally strategic 'growth triangle; which will drive regional growth by providing a large and skilled population base, substantial capacity for additional residential and employment related functions, and an improving transport network. In February 2013, it was announced that the NSS would be cancelled and replaced by a new policy in about a year's time.

The National Development Plan (NDP), 2007-2013, states that regional population and economic trends have implications for transportation. When this Plan was written, a rapidly increasing population, together with rising employment and income levels, had resulted in car ownership levels in Ireland increasing significantly. The population of Kilkenny City and its Environs grew by 6% between 2002 and 2007. In 2007, a review of the NSS suggested a target population for Kilkenny City and Environs of 30,000 persons by 2020. In 2010, the South East Regional Planning Guidelines revised this and projected that Kilkenny city will reach a population of 28,200 by 2022.

This population growth will lead to increased traffic, and a need to cater in an appropriate manner, for this traffic volume. The proposed Scheme will provide a critical element of the necessary infrastructure to cater for this increase in traffic.

2.3.2 'Smarter Travel – A Sustainable Transport Future'

'Smarter Travel – A Sustainable Transport Future' is the Government's transport policy for the period 2009-2020. It sets out the vision, goals and targets for achieving a more sustainable transport future and includes 49 sections to achieve these objectives. Most of these actions are 'soft' measures intended to complement existing and on-going investment in physical infrastructure, which will *"remove bottlenecks, ease congestion and pressure in towns and villages and provide the necessary infrastructural links to support the National Spatial Strategy".*

One of the stated goals of the policy document is to *"improve economic competitiveness through maximising the efficiency of the transport system and alleviating congestion and infrastructural bottlenecks".*

The proposed Scheme addresses a physical infrastructural deficit in Kilkenny City and County, and it includes measure to address and facilitate the implementation of the sustainable objectives of 'Smarter Travel – A Sustainable Transport Future'. The Scheme will encourage sustainable transport modes through the incorporation of safe footpaths and cyclepaths which are segregated from vehicular traffic. This Scheme will also alleviate congestion in the City Centre, facilitating the improvement of pedestrian areas and the provision of traffic-free areas.

The Kilkenny Local Authorities (KLA) are committed to the principles underlying 'Smarter Travel – A Sustainable Transport Future'. A key objective is the development of "a ten minute walking and cycling city". The realisation of this Scheme will enable the achievement of this objective by reducing traffic congestion and creating improved conditions for the implementation of sustainable transport measure for both pedestrians and cyclists. The KLA were successful in their bid under the Active Travel Towns programme. The realisation of this Scheme will enable the achievement of this objective by reducing traffic congestion and creating improved conditions for the implementation of sustainable transport measures for both pedestrians and cyclists.

2.3.3 Kilkenny City and Environs Development Plan 2008-2014

This Development Plan provides the land use and planning policy framework to guide the development of Kilkenny and its environs in achieving the objectives and targets of national and regional policy documents such as the NSS and the South East Regional Planning Guidelines (RPG) which define Kilkenny City as a 'Hub' town.

This plan sets out a number of strategic goals, including:

- To guide the location and pattern of development whilst ensuring that a relatively urban form is maintained;
- To develop an integrated transport strategy for the City and Environs linked to land use objectives, which facilitate access to a range of transport modes; and
- To promote the regeneration of the City Centre, in particular the sites identified in the City Centre Local Area Plan, and to protect and promote the City Centre as the commercial and cultural focus for Kilkenny City and Environs.

In addition to protecting and enhancing the built and natural heritage of Kilkenny, the Development Plan strongly promotes balanced development, a vibrant City Centre and a compact urban form.

The plan identifies this Scheme as a line on the Kilkenny City & Environs Development Plan 2008-2014 maps.

Section 7 of the Planning and Development (Amendment) Act 2010, sets out that the written statement of a Development Plan must contain a Core Strategy which shows that the development objectives in the development plan are consistent, as far as practicable, with national and regional development objectives set out in the NSS and Regional Planning Guidelines (RPGs). The Kilkenny County Council Core Strategy is published as Variation No. 1 to the Kilkenny City & Environs Development Plan 2008-2014. In 2010, and it includes the projected population of Kilkenny city and county by 2022, which will inform appropriate infrastructure development levels during this period.

2.3.4 Kilkenny County Development Plan 2008-2014

This Development Plan acknowledges that "*transport plays a central role in the economy. The development of an efficient strategic transport system in line with national policy is essential to the future economic, social and physical development of the county. Transport policy and planning, and land use policy are fundamentally linked."*

It states that *"a core aspect of the approach is the enhancement of connectivity at national, regional and local levels. The availability of an efficient, predictable and sustainable national transport network is a key factor underpinning economic growth and competitiveness and in improving quality of life."*

The proposed Scheme meets all of the following Development Plan objectives:

- IE1 Develop an integrated sustainable system of transport for the county involving road, rail, bus, cycling and walking.
- IE2 To facilitate the development of alternative transport initiatives particularly in rural areas in order to reduce isolation and promote social inclusion.
- IE3 Co-operate with the National Roads Authority in the development of an integrated road network for the County.
- IE4 To improve facilities for pedestrians and access facilities for people with special mobility needs in line with the aims of the European Charter of Pedestrian Rights.

It is also an objective of this Development Plan "To seek an upgrade of the Kilkenny to Urlingford road (R693) to National Secondary status and to improve the road realignment in its entirety. This Scheme facilitates this objective by directly linking the existing N77 Ring Road Extension to this proposed national route.

2.3.5 Kilkenny City Centre Local Area Plan 2005

The Kilkenny City Centre Local Area Plan 2005 (LAP) provides the planning framework for a holistic approach to securing the continued vitality and viability of the City Centre through sustainable planning

and to achieve a balance between preserving its architectural and archaeological heritage, facilitating modern living and enhancing the quality of life for its existing and future residents.

A suite of traffic management policies and measures is proposed in the LAP to improve existing vehicular and pedestrian linkages within the City Centre. The proposed Scheme will facilitate these measures by reducing the levels of through traffic and HGVs using the City Centre streets.

2.3.6 Regional Planning Guidelines for the South-East Region 2010-2022

These Guidelines support the completion of the Kilkenny Ring Road. They also support the upgrading of the R693, which provides an important link to the M8/M9 and an important link between the hubs of Kilkenny and Wexford.

3.0 ALTERNATIVES

3.1 Introduction

This Chapter contains an outline of the main alternatives studied and an indication of the main reasons for the choice of preferred route option. Preliminary design work and environmental assessment has been carried out on this project since 2008. In this period a number of alternatives were considered prior to, and during, the route selection stage. The analysis between options considered the following elements:-

- Environmental impacts – people and communities, ecology, archaeology, landscape, air, noise and agriculture.
- Engineering impacts – property effects, engineering characteristics of the route, structures, etc.
- Traffic impacts.
- Economics – value for money and absolute cost.
- Public consultation – feedback from the Local Authority, landowners, interest groups and members of the public.

The detailed assessment of the alternative routes is provided in the Constraints and Route Option Study.

3.2 Alternative Horizontal Alignments

The horizontal alignment is largely constrained by the end connection points at the R693 Freshford Road and the N77 Castlecomer Road/N77 Kilkenny Ring Road Extension. At the Castlecomer Road/N77 Kilkenny Ring Road Extension there is an existing roundabout, which forms our tie-in point. The existing N77 Ring Road Extension is in substantial cutting as it approaches the roundabout. An alternative tie-in location north of the current roundabout, while geometrically possible, would substantially add to traffic levels on the Castlecomer Road between the N77 Ring Road Extension and the new tie-in location. In addition, a route tie-in to the Castlecomer Road further north would have greater potential impacts on archaeology and material assets.

At the R693 Freshford Road there were a number of possible tie-in locations with satisfactory geometrics. The preferred tie-in point is closest to Kilkenny City, allows the shortest route requiring the least landtake and the least severe severance, allows the shortest crossing of the River Nore and its cSAC, and avoids areas of archaeological importance that were impacted on by alternative routes.

Eight route options were originally developed for consideration, as detailed in the Constraints and Route options report. Following a detailed examination of physical, archaeological and environmental constraints and a review of geometric standards and engineering optimisation, Route 8 was selected.

Route 9, the preferred route, was developed as a local amendment to Routes 7 and 8 to minimise the impact on the cSAC as part of the Flora and Fauna route option assessment and Natura Impact screening.

Figure 3.01 shows the nine horizontal alignment options considered.

3.3 Alternative Vertical Alignments

The vertical alignment is influenced by the need to ensure the proposed River Nore bridge structure maintains adequate clearance above predicted flood levels for the River Nore. At the bridge location, the land to the east of the river is a floodplain, and the vertical alignment through this floodplain must also ensure that there is adequate clearance over flood levels. The 1/100 year flood level has been predicted to be 49.410m AOD at the proposed River Nore bridge location. The minimum soffit level on the River Nore bridge is 50.520m which allows for a 20% increase in the 1/100 year flood flow plus adequate freeboard. The proposed vertical alignment on embankment through the flood plain also facilitates the headroom required for farm underpasses in the fields on either side of the Bleach Road.

The preferred alignment Scheme provides access between the new Kilkenny Northern Ring Road Extension and the Bleach Road north of the scheme, hence providing enhanced road access to Kilkenny City and the Strategic Road network from the Bleach Road. The existing Bleach Road north of the Scheme will run up to a T-junction with the proposed road. The Bleach Road south of the Scheme will run into an underpass that will allow only cars, pedestrians and cyclists access to the Bleach Road north of the Scheme. The road from under the underpass will run to a t-junction with the road that accesses the proposed Scheme, providing access to the Scheme for residents south of the proposed road.

Vertical Alignment options considered included a full height grade separated junction at the Bleach Road, as per Figure 3.02, to leave the Bleach Road as it currently is, and allowing all traffic to pass along it. The full grade separation of Bleach Road would require significant increased embankment height. This would require far increased landtake to allow for the embankment in addition to increased earthworks in terms of removal of material and importation of material to provide an adequate foundation for this increased embankment.

3.4 Alternative Bridge Design

The preferred option for the River Nore Bridge is a three-span structure with a centre span of 45m and edge spans of 22.5m each, supported by abutments at each end. The bridge piers will be set back several metres from the river banks. This option is preferred over the option of a clear 50m span as it reduces the structural depth by making use of the hogging moments over the intermediate supports. Alternative designs, such as two 25m spans with a central pier within the river bed, were discounted due to ecological and hydrological concerns.

3.5 Alternative Culvert Design Through Flood Plain

Approximately 360m length of the proposed road runs through a major floodplain of the River Nore. This is the stretch of land from the river to the Bleach Road, and it conveys water during a major flood event. A further 500m length of road, from the Bleach Road running east, also floods during major flood events. A number of options were considered for crossing this floodplain. The need to maintain it as a floodplain that can drain to the river in a similar way to how it currently behaves following flooding was acknowledged and accepted early in the design process. Building the road over the floodplain on an embankment without allowing for the behaviour of the floodplain was not considered as a viable option. Bridging the 360m length in a similar fashion to the proposed River Nore bridge was considered but was discounted in favour of a more cost effective solution. The preferred option is to provide 16No. culverts evenly spaced through the 360m length of floodplain west of the Bleach Road. 13No. of these culverts will be 10 wide and 3.6m high arched culverts, and the other 3No. will be 10 wide and up to 4.5m high box culverts with access roads to allow them to act as farm underpasses. 4No. 10 wide and at least 3.6m high box culverts will be provided on the east side of the Bleach Road, which will accommodate farm underpasses and allow the movement of water in flood events. The Bleach Road will be maintained as a local access underpass under the proposed road, which will provide a 21st culvert during major flood events. These culverts will allow the flood water to dissipate following a flood event at the same rate and in the same manner as that which occurs at present.

A number of design features have been incorporated into this section of the road in order to reduce the significant cost of providing these flood protection measures. These include using reinforced earth embankments which can be constructed at a steeper grade and, therefore, reduce the overall footprint of this 360m length of road. Reducing the footprint through the floodplain has two cost saving advantages. Firstly, it reduces the volume of dig and replace material from under the embankment and, secondly, it reduces the length of the arched culverts running under the road.

4.0 DESCRIPTION OF THE PROPOSED DEVELOPMENT

4.1 Introduction

This Chapter describes the proposed Scheme in detail under the following headings:

- Road Design;
- River Nore Bridge Crossing;
- River Nore Flood Plain Crossing;
- Cyclist and pedestrian facilities;
- Lighting;
- Earthworks;
- Utilities;
- Landtake; and,
- Construction.

The proposed Scheme is illustrated on Figure 4.01 while cross-sections are shown on Figure 4.02. The proposed River Nore bridge is shown on Figure 4.03.

4.2 Description of the Proposed Development

4.2.1 Road Design

The proposed Scheme has been planned as a regional road with an 80kph speed limit. However, the road has been designed to a 100kph speed limit, which will facilitate a speed limit increase should the road be upgraded to a national route in the future.

The vertical alignment of the road has been designed to allow for 1/100 year flood levels plus 20% additional flow to allow for increases in flow due to climate change. This 20% additional flow is recommended for all strategic infrastructure.

The radii used in the horizontal alignment described below are the minimum desirable radii for a 100kph design speed. The proposed cross-section of the road will consist of two 3.65m lanes for motor vehicles, two 2.5m hard shoulders, a 1.5m verge, 1.75m 2-way cycletrack, and 1.8m footpath on the city side of the road, and a 3.0m verge on country side. At the proposed River Nore bridge and on the reinforced earth embankment through the floodplain the proposed cross-section of the road will consist of two 3.65m lanes for motor vehicles, two 0.5m hard shoulders, a 1.5m verge, 1.75m cycletrack, and 1.8m footpath on the city side of the road, and a 1.5m verge on the northern side.

Examining the horizontal alignment, from the west end at the R693 Freshford Road, the road will follow a long 390m straight north east as far as the bridge over the River Nore. The road crosses the river on a straight alignment at a skew of approximately 70 degrees to the river. After the bridge

crossing the road curves west with a radius of 510m at approximately Ch 440. The alignment then straightens again for approximately 490m between Ch 630 and Ch 1120 running west before curving south with a radius of 510m. The approach to the existing Castlecomer Road roundabout is a 110m straight from approximately Ch 1350. The proposed Scheme meets the existing three arm roundabout to form its western arm. The horizontal alignment at the approach to the roundabout has been designed to minimise impact on the cSAC.

From the west end, the vertical alignment of the road allows a balance of cut and fill volumes over the first 390m and falls continuously towards the river. The bridge will cross the River Nore above the predicted 1 in 100 year flood level. The 1 in 100 year flood event has been modelled and the predicted flood level is 49.41m AOD (see Chapter 8). The minimum soffit level of the bridge will be above 50.520m, which allows 300m freeboard and the additional 20% flow recommended by the OPW to allow for climate change.

Following the bridge, there is approximately 360m of up to 6m high embankment through the floodplain of the River Nore. This embankment will have 16No. culverts evenly spaced, 13No. of which will be 10 wide and 3.6m high arched culverts, and the other 3No. will be 10 wide and up to 4.5m high box culverts with access roads to allow them to act as farm underpasses. An underpass for local traffic (cars, pedestrians and cyclists only) will be provided at the location of the existing Bleach Road. The road will then rise gently towards a high point at Ch 1310 before falling gently towards the existing roundabout at the Castlecomer Road. The road is on embankment of up to 5m as far as Ch 1290. 4No. 10 wide and at least 3.6m high box culverts will be provided in this embankment, which will accommodate farm underpasses and allow the movement of water in flood events.

The junctions at either end of the proposed Scheme will be roundabouts. These will be a newly constructed roundabout at the junction with the R693 Freshford Road, and the existing roundabout at the junction of the N77 Kilkenny Ring Road Extension and the N77 Castlecomer Road. The Bleach Road will become an underpass under the proposed road at the city side of the proposed Scheme, and will form a t-junction with the proposed Scheme on the northern side.

4.2.2 River Nore Bridge Crossing

The proposed bridge is designed as a three-span structure with a centre span of 45m and edge spans of 22.5m each, supported by abutments at each end. The proposed bridge is designed to carry paved areas 14.95m in width.

The proposed bridge supports a carriageway with 4.15m wide lanes in each direction. There will be a 1.5m verge, 1.75m cycletrack, and 1.8m footpath on the city side of the road, and a 1.5m verge on country side of the proposed bridge giving the overall width of 14.95m.

The proposed bridge deck comprises of a maximum 2500mm deep steel structure supporting the 14.95m wide carriageway, over 3 spans as shown on Figure 4.03. The reinforced concrete abutments and piers will be formed from columns which are in the region of 1m in diameter which are, in turn, supported on concrete pile caps on piles.

4.2.3 River Nore Flood Plain Crossing

The River Nore floodplain west of the Bleach Road will be crossed by 16No. culverts evenly spaced, 13No. of which will be 10 wide and 3.6m high arched culverts, and the other 3No. will be 10 wide and up to 4.5m high. Through the floodplain the paved area will be 14.95 in width, comprised of 4.15m wide lanes in each direction, a 1.6m verge, 1.75m cycletrack, and 1.8m footpath on the city side of the road, and a 1.5m verge on country side.

The 16No. culverts will allow the flood water to dissipate following a flood event at a rate and in a manner similar to that which occurs at present. The embankments through the flood plain will be constructed using reinforced earth which can be constructed at a steeper grade and, therefore, reduce the overall footprint. Reducing the footprint through the floodplain reduces the volume of dig and replace material from under the embankment, and reduces the length of the arched culverts running under the road.

4No. 10 wide and at least 3.6m high box culverts will be provided on the east side of the Bleach Road, which will accommodate farm underpasses and allow the movement of water in flood events. The Bleach Road underpass will provide a further culvert for the dissipation of water during a major flood event.

4.3 Cyclist and Pedestrian Facilities

To cater for pedestrians and cyclists, a 1.8m footpath and a 1.75m off road cycle track will be provided on the city-side of the proposed road.

The junctions at either end of the proposed Scheme will be roundabouts. Dropped kerbs, complete with appropriate tactile paving, will be provided at appropriate locations to allow pedestrians and cyclists to cross the carriageway safely.

Pedestrian access will be provided to the city side of the proposed road at Bleach Road. Dropped kerbs will be provided to allow pedestrians and cyclists access to Bleach Road from the city-side of the proposed road.

4.4 Lighting

Lighting appropriate for a road in a rural setting will be installed along the proposed Scheme. Horizontal cut-off light fittings will be used to retain light spill to the proposed Scheme corridor.

4.5 Drainage

The drainage networks for the proposed Scheme are split by the River Nore.

West of the River Nore the balance of cut and fill allows the road to fall continuously towards the river from the R693 Freshford Road. The western drainage network will collect the surface water runoff and direct it to an outfall to the River Nore adjacent to the proposed bridge. Oil pollutants and sediments in the runoff will be removed by oil and grit interceptors at carriageway level in accordance with recognised best practice.

On the eastern side of the River Nore, the Scheme drains away from the river as far as Ch. 870 and towards the river from Ch. 870 to Ch. 1310. It is proposed to acquire land to construct a drain running to the River Nore along the north and south sides of the proposed Scheme, which can accommodate the varying falls in the road from the river to Ch. 1310. Treatment of the discharge will be achieved by the same interceptor arrangement as proposed for the western drainage network that is described above. From Ch. 1310 to the existing roundabout on the Castlecomer Road, the Scheme drains towards this roundabout. It is proposed to add this runoff to the existing drainage systems at this roundabout.

4.6 Earthworks

The proposed Scheme will require some significant earthworks. The alignment from approximately Ch. 0 to Ch. 400 will require excavation and filling. The depths of excavation do not exceed 2.5m and filling does not exceed 4.0m. It is expected that some of the excavated material will be suitable for re-use in the embankments. Additional suitable material will be imported from a suitable local source.

Due to the poor ground conditions, it is envisaged that 3-5m of material will have to be removed and replaced between Ch. 450m and Ch. 1300. On top of this replaced material, an embankment of up to 6m in height will be constructed. All this fill material will be imported from a suitable local source. Ground stabilisation will be considered as an alternative to dig and replace, if this is deemed appropriate and cost effective.

Between Ch. 1300 and the existing roundabout at Ch. 1450, up to 1m of fill will be required, and will be imported from a suitable local source.

Structural backfill will need to be imported for both abutments of the proposed bridge.

All unsuitable material will be removed from site and disposed of in accordance with all relevant Waste Management Legislation.

4.7 Utilities

It is likely that diversions will be required wherever the proposed Scheme crosses services, though protection of apparatus may be adequate in some cases. Connections to properties may be affected during diversion works in some locations. A number of overhead 10kV electricity lines and eircom lines cross the proposed road line, which will be diverted underground underneath the road. Watermains on the Bleach Road (75mm diameter uPVC) and R693 Freshford Road (600mm diameter A.C.) may also be affected.

4.8 Land Take

The total area of land required for the Scheme is approximately 7.15 hectares. Most of the land is in agricultural use at present, and is owned by 3No. landowners (6.05 hectares).

4.9 Construction

4.9.1 Pre-Construction Works

Additional geotechnical investigation will also be carried out pre-construction. A geotechnical investigation will typically comprise of the supervised excavation of boreholes and trial pits. Moderately sized plant will be used and consist of small to medium sized excavators, cable percussive rigs, rotary drilling rigs, compressors, water bowsers, low loaders and 4-wheel drive vehicles.

Slit trenches will also be required at selected locations in order to confirm the location of buried services. Saw cutting of the existing pavement and the subsequent hand excavation, photographing and logging of the uncovered services will be the main activities. Archaeological test trenches will also be dug pre-construction.

To confirm the ground conditions for the proposed River Nore bridge supports, boreholes will be drilled at relevant locations.

All works undertaken as part of the ground investigation contract will be undertaken in accordance with recognised best practice procedures in order to ensure that they do not result in any environmental impacts.

4.9.2 Main Construction Works

Construction Compounds and Working Space

A construction compound or compounds will be required for the duration of the construction works. The optimum location of the construction compound(s) will be determined prior to the commencement of construction. Kilkenny County Council does not propose to acquire land for this purpose.

All construction phase mitigation measures outlined in this EIS will apply to the construction compounds, wherever they are to be located.

The requirement for temporary working space during the construction works has been considered in the determination of the Compulsory Purchase Order (CPO).

Potential Impacts on Adjacent Landowners

Residents of the areas of the Castlecomer Road (including the Weirview development), the Bleach Road, and the R693 Freshford Road (including Auteven Hosptial) closest to the construction works will experience some level of noise, vibration and dust arising from general works and construction traffic in close proximity to their properties. Service diversion works may also directly affect these properties.

Revised access arrangements, both permanent and temporary, will be required for all three affected landowners.

Traffic Management

The impact of construction on users of the existing road network will be relatively small because the proposed development has relatively few interfaces with main roads. Temporary traffic management, including diversions and access restrictions, will be required at the Bleach Road and R693 Freshford Road. Minor traffic management will also be required at the Castlecomer Road roundabout.

4.9.3 Environment Management During the Construction Phase

During the construction phase the methods of working will comply with all relevant legislation and best practice in reducing the environmental impacts of the works. Although construction phase impacts are generally of a short-term duration and are localised in nature, the impacts will be reduced as far as practicable through compliance with the mitigation measures stated in this EIS, current construction industry guidelines (such as CIRIA C502 Environmental Good Practice on Site, etc.) and current NRA Environmental Construction Guidelines.

The relevant guidance and best practice requirements will be formalised in the Environmental Operating Plan (EOP) which will be prepared in accordance with “Guidelines for the Creation, Implementation and Maintenance of an EOP, 2007” published by the NRA as part of the overall mitigation strategy. The EOP will assist in preventing, managing and/or minimising significant environmental impacts during the construction phase. To achieve this objective the EOP will:

- Incorporate all Environmental Commitments/Mitigation Measures set out in the Contract documents which will include conditions of any Approval as may be granted and any further requirements of Statutory Bodies;
- Provide a method of documenting compliance with these Environmental Commitments/Mitigation Measures;
- List all relevant environmental legislative requirements and provide a method of documenting compliance with these requirements; and,

- State methods by which construction work will be managed to avoid, reduce or remedy potential adverse impacts on the environment.

Details of the predicted impacts and mitigation associated with the construction of the proposed Scheme are included within the relevant chapters of this EIS (Chapters 6.0 – 14.0) and within the schedule of environmental commitments presented in Chapter 15.0. In general, disturbance arising from construction may result from various activities including preparatory works, diversion of services, noise and vibration from plant, excavation and fill operations, stockpiling and handling, construction traffic, severance of roads and accesses and the specific member of staff to liaise with landowners, householders and the general public throughout the construction phase.

A Project Construction and Demolition Waste Management Plan will also be prepared and maintained in respect of the proposed Scheme and the NRA guidelines entitled 'Management of Waste from National Road Construction Projects, 2008' will be followed.

4.10 Health and Safety

4.10.1 Design and Construction Health and Safety

The proposed road has been designed in accordance with the Safety Health and Welfare at Work Act, 2005 and the Safety, Health and Welfare at Work (Construction) Regulations, 2013. The following principles are incorporated into the design of the proposed Scheme:

- The road will be designed by skilled personnel according to internationally recognised standards, design codes, legislation, good practice and experience.
- Design risk assessments will be carried out to check for safety hazards and for ease of operability.
- The design will comply with the NRA Design Manual for Roads and Bridges.
- Road Safety Audits will be carried out on the design at appropriate stages.

Kilkenny County Council employs a Project Supervisor Design Process (PSDP) to oversee the coordination of the design work. Kilkenny County Council also provide Health and Safety training for relevant staff where required.

It is the policy of Kilkenny County Council to attach the greatest importance to the health and safety of all persons employed on the project and indirectly affected by the works. All construction projects are carried out, so far as is reasonably practicable, in such a way that the risks to the health and safety of all persons engaged in, or affected by, its construction and maintenance are eliminated or reduced to an acceptable level under current health and safety legislation, namely the Safety, Health and Welfare at Work (Construction) Regulations, 2013 and good practice.

Kilkenny County Council employs a Project Supervisor Construction Stage (PSCS) to act as health and safety co-ordinators ensuring that relevant legislation is adhered to and that best practice in health and safety is employed and enforced during construction.

Kilkenny County Council will apply strict rules on safety such as road opening licences for contractors and service providers, approved traffic managements plans for all works that impact on existing live roads, suitably trained and competent construction managerial personnel, and use of personal protection equipment where appropriate during construction.

4.10.2 General Operational Safety

The operation of the proposed road will involve hazards associated with live traffic on a high speed road, and the interaction of various modes of transport including HGVs, farm machinery, cars, cyclists and pedestrians. During the detailed design phase of the road, risk assessments and Road Safety Audits will be carried out. These studies are systematic methods of identifying hazards and assessing mitigation measures. This EIS identifies the aspects of the proposed road's operation that can interact with the environment and determines where controls are required.

Kilkenny County Council will be responsible for maintenance of the proposed Scheme. Ongoing maintenance of the road will ensure the provision of a quality facility for all road users and will control the environmental and health and safety impacts of the road into the future. By employing competent experienced personnel, Kilkenny County Council aims to ensure that all members of road maintenance staff are in possession of the knowledge, skills and experience necessary to perform their jobs to a satisfactory standard.

Prior to the opening of this road, a comprehensive set of operating procedures will be drawn up. The purpose of these procedures is to ensure that Kilkenny County Council:

- maintains control over the quality and safety of the Scheme,
- meets the aims laid down in the Environmental and Health & Safety Policies, and
- remains compliant with all relevant legislative requirements.

4.10.3 Potential Operating Hazards and Proposed Preventative Safety Measures

Surface Water

The build up of surface water during storm events is an issue for all road schemes. Correct design and construction of the road should ensure that surface water runoff is at an acceptably safe level, even in extreme storm events. The surface water drainage system will be designed to take the required volume of surface water. Surface water drainage systems will be adequately maintained by Kilkenny County Council to ensure that they perform as required when needed.

Surface Ice

The presence of ice on the road surface is a hazard during freezing weather in winter and spring for all roads in Ireland. During extreme cold periods, Kilkenny County Council will de-ice main routes, such as the proposed Scheme. Maintenance of the surface water systems will also ensure that surface water will not have built up on the road surface prior to freezing weather.

Flooding

The road will be constructed through a major floodplain of the River Nore. The potential for the road to flood will be mitigated against by constructing it above the flood level for a 1/100 year flood plus 20% additional flow for climate change flow increases.

High Embankment

As the road will be constructed above the 1/100 year flood level through the flood plain it will be on very significant embankment (5 – 6m) for a significant portion of its length. The hazard that this high embankment causes for drivers and other road users will be mitigated against by providing a crash barrier and fence where needed.

4.10.4 Safety Features

Public Lighting

Public lighting will be provided along the length of the proposed Scheme improving the safety for all road users after dark.

Roundabout Junctions

Roundabouts will form the junctions of the proposed Scheme with the Castlecomer Road and the Freshford Road. These will allow safe and efficient access onto and off of the road.

Right Turn Pocket

A right turn pocket will be provided for cars turning from the proposed Scheme onto the Bleach Road. This provides a safer environment for cars who want to make this movement.

Crash Barriers

Crash barriers will be provided at the top of the high embankment and at the sides of the bridge to prevent vehicles from going over the edge in the event of an accident.

Tactile Paving

Tactile paving will be provided wherever kerbs are dropped to alert the visiaully impaired that they are entering the carriageway.

5.0 TRAFFIC AND ECONOMIC ASSESSMENT

5.1 Traffic Assessment

5.1.1 Introduction and Context

The traffic modelling and forecasting for this EIS were undertaken using the Kilkenny City Traffic Model (KCTM). This model was originally developed around 2000 using SATURN computer software. This computerised model was further developed and updated using traffic data observed in late 2006 to calibrate and validate the model. The 2006 model passed all the validation criteria as set out in the DMRB. There were three separate reports, namely a Traffic Survey Report, a Validation Report and a Forecasting Report, authored at this time in support of the work carried out with the model.

During the preparation of this EIS, the model was updated using traffic data from 2012 and 2013 and revised traffic forecasts. The projected development inputs for the traffic forecasts were agreed with Kilkenny County Council Planning Department and were informed by the Regional Planning Guidelines and projected Residential, Industrial and Commercial development. More detailed information on these projections is provided below. The model would then be able to forecast the changes in traffic flows that would result from the construction of the proposed Scheme.

5.1.2 Forecast Years and Scenarios

Forecasts were undertaken for the following years:

- 2019 (proposed year of opening of the proposed Scheme); and,
- 2034 (design year, 15 years after opening of the proposed Scheme).

Forecasts were undertaken for the following two scenarios to allow the outcomes to be compared:

- Do Minimum; and
- Do Something

The Do Minimum (DN) scenario includes the existing road network plus future road schemes, other than the proposed Scheme, that have been projected to be operational in 2019 and 2034 including the proposed Central Access Scheme. The Do Something (DS) scenario comprises the road network as defined in the DM scenario plus the proposed Scheme in both 2019 and 2034. A list of the future schemes with the year (in brackets) in which each scheme is introduced into the model for the scenarios is provided below:

- Kilkenny Central Access Scheme Phase 1 (2019)
- Smithlands Access Road (2034)
- Realignment of Kilkenny Ring Road between the N10 and the N76 (2034)
- Kilkenny Central Access Scheme Phase 2 and 3 (2034)
- Kilkenny Western Environs (2034)

Figure 5.01, 5.02 and 5.03 show the existing, proposed 2019 and proposed 2034 road networks as inputted to the model.

5.1.3 Traffic Growth

Traffic growth that will occur in the period 2013 – 2034 was predicted for the purpose of this model. Traffic growth will occur from the traffic generated by specific developments that are currently predicted to occur within Kilkenny in the period up to 2034. Trips associated with these developments were estimated using trip rate assumptions extracted from the TRICS database which is accepted best practice for this type of modelling. No baseline annual traffic growth was included.

A detailed review of the existing traffic model was carried out including a sense check on the land use assumptions previously made against developments complete. Figures 5.05, 5.06, and 5.07 show the traffic zones included in the model. Following a sense check of the zone origins and destinations the model was recalibrated to 2013 based on recent traffic survey data. See Appendix F for traffic count data that was gathered specifically for this Scheme. Several counts that were carried out by Kilkenny County Council in other areas of the City were also used in the calibration of the model.

Based on the current land-use planning (see Figure 5.04), the Regional Planning Guideline projections and projected industrial and commercial development the model zones were updated for2019 and 2034 projected demands.

The following assumptions have been made with regard to key development sites within Kilkenny:

- Some development of the Brewery and Old Mart brown field sites to occur by 2034.
- Residential development at Loughmacask will be 270 additional units in 2019 and 450 additional units in 2034;
- Residential development in the Western Environs will be 250 additional units by 2019 and 1560 additional units by 2034;
- Development of substantial areas of industrial zoned lands to the west and south of the City by 2034.

Using the above assumptions, Table 5.1 below lists a summary of percentages of traffic growth that are predicted to occur in Kilkenny for the period of 2013 – 2034.

Table 5.1 – Summary of 2013 – 2034 Traffic Growth

	AM	PM
2013 - 2019	9.4%	13%
2019 - 2034	49%	52%

This equates to an average growth rate per annum of 1.75% between 2013 and 2019 and of 2.75% between 2019 and 2034. These growth assumptions are based on projected development and population increase. No background growth in car ownership has been included.

5.1.4 Traffic Flows in Forecast Year

Tables 5.2, 5.3 and 5.4 below provide summaries of the two-way flows during the peak hours crossing the River Nore in 2013 and in the forecast years of 2019 and 2034 for the DM and DS scenarios.

Table 5.2 – 2013 Traffic Flows Crossing River Nore

2019 Flows		
Location	**AM Peak**	**PM Peak**
	DM	**DM**
John's Bridge	680	830
Green's Bridge	1374	1450
N10 Ring Road (Ossary Bridge)	2344	2396
Totals	**4398**	**4676**

Table 5.3 – 2019 Traffic Flows Crossing River Nore with CAS

2019 Flows				
Location	**AM Peak**		**PM Peak**	
	DM	**DS**	**DM**	**DS**
Proposed Scheme		649		608
John's Bridge	497	508	653	633
Central Access Scheme	774	574	922	626
Green's Bridge	955	711	997	821
N10 Ring Road (Ossary Bridge)	2800	2816	2774	2813
Totals	**5026**	**5258**	**5346**	**5501**

Table 5.4 – 2034 Traffic Flows Crossing River Nore with CAS

2034 Flows				
Location	**AM Peak**		**PM Peak**	
	DM	**DS**	**DM**	**DS**
Proposed Scheme		1392		1208
John's Bridge	1219	1108	1363	1247
Central Access Scheme	1994	1579	1523	1021
Green's Bridge	1512	1046	1403	1033
N10 Ring Road (Ossary Bridge)	2435	2247	2879	2797
Totals	**7160**	**7372**	**7168**	**7306**

Figure 5.08 gives the corresponding Do Minimum and Do-Something AADT flows for 2019 and 2034. Reviewing the DM results it can be seen that there will be a significant growth demand for movements across the River Nore in comparison to the 2013 Base Year Flows. The increases will amount to approximately 62% and 53% in the AM and PM Peak periods by 2034. This will result in significant increases in delay and congestion on these existing crossings.

Analysis of the DS flows confirms that the introduction of the proposed Kilkenny Northern Ring Road Extension River Nore bridge crossing will provide significant relief to all other river crossings in all three time periods when compared to the DM scenarios flows. The greatest relief will be provided to the Green's Bridge crossing which will show reductions in flows in 2034 of 33% and 27% in the AM and PM Peaks respectively. The Central Access Scheme shows a 33% reduction in the PM Peak also. In the opening year of 2019, traffic flows on Green's Bridge in the peak hours are similarly reduced.

Reductions in flows in the City Centre will enhance the general amenity of the City Centre streets. The predicted reductions in traffic volumes will make for a safer environment for both pedestrians and cyclists.

5.1.5 Modal Shift

Kilkenny County Council are seeking to implement initiatives to encourage the use of public transport, cycling and walking as transport alternatives with the City Centre. Previous studies of the uptake of these types of transport alternatives by the public in other cities have shown that a 15 to 20% shift in the mode of transport may be realised. In order to obtain such targets in the City Centre, it is important that a safe and pleasant environment is provided to facilitate the implementation of modal shift initiatives. The proposed Scheme will directly provide such an environment as it will cater for public transport, cyclists and pedestrians.

5.1.6 Summary

The assessment of the traffic modelling described above confirms the need for the proposed Scheme. In the absence of the proposed Scheme, the traffic congestion currently being experienced on John's Bridge and Green's Bridge will continue to increase. This congestion will prevent the proposed improvements to public transport and facilities for pedestrians and cyclists in the City Centre by the Local Authority, from being implemented.

A summary of the forecast year assignment flows on key links within Kilkenny for the DM and DS scenarios for 2034 in the AM Peak is provided in Table 5.5.

Table 5.5 – Summary of Traffic Flow on Key Links (Two way peak hourly flows)

Road Link	Do Minimum		Do Something	
	am	pm	am	pm
Proposed Scheme			1392	1208
Ring Road (east of Castlecomer Road)	631	787	1139	1098
Castlecomer Road (North of new Road)	1335	1336	1155	1098
Freshford Road at Bishops Hill	629	778	217	158
Freshford Road at Auteven Hospital	1336	1337	1651	1372
John's Bridge	1219	1363	1108	1247
Green's Bridge	1512	1403	1046	1033
Central Access Scheme Bridge	1994	1523	1579	1021
Hebron Road at Station	1092	1267	1155	987
Dublin Road at Station	1055	986	827	889

Table 5.5 shows that the proposed scheme provides significant traffic relief in the City Centre, not only on the bridge crossings, but also the Dublin Road, Hebron Road, Castlecomer Road, and Freshford Road.

5.2 Economic Assessment

An economic assessment of the proposed Scheme based on NRA Cost Benefit Analysis guidance has been undertaken using information from the DM and DS forecasts. The results of this analysis are summarised below in Table 5.6. The results confirm that the proposed Scheme shows a positive Benefit to Cost Ratio (BCR) of 3.66 which indicates that the proposed Scheme is economically viable.

Table 5.6 – Summary of COBA Assessment of proposed Scheme

Expenditure	**€000s**
Do Something Scheme cost	10,470
Do Minimum Scheme cost	0
Present Value of costs (PVC)	8,274
Benefits	
Present Value of Benefits (PVB)	**33,860**
Net Present Value (NPV)	**24,611**
Benefit/Cost Ratio	**3.66**

There are other non-tangible benefits which will accrue to the citizens of Kilkenny, through the provision of cycletracks and footpath as a walking route and extension of the existing cycletracks and footpaths on the Ring Road, reduced accident risk and improved environment in the City Centre which have not been assessed through the above analysis but will clearly enhance the overall benefit value in relation to costs.

6.0 HUMAN BEINGS

6.1 Introduction

This chapter of the EIS presents the likely impacts of the proposed Scheme on the human environment within Kilkenny City and the countryside adjacent to the Scheme. The impacts of the Scheme on human beings will be influenced by many issues which are discussed in separate chapters of this EIS. These topics include Air Quality and Climate (Chapter 10), Noise and Vibration (Chapter 11), Landscape and Visual (Chapter 12) as well as Material Assets (Chapter 14). Therefore this chapter of the EIS focuses on the potential impacts of the Scheme on the remaining aspects of the human environment which are as follows:

- Land Use and Settlement Structure, which incorporates an assessment of potential impacts on population settlements, community facilities/recreational land, tourism and local business.
- Travel times for Road Users and Community Severance, which incorporates an assessment of the potential impact on journey length and travel patterns, community severance, and relief from existing severance.

6.2 Assessment Methodology

The study methodology followed that outlined in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 6 – Land Use, and Part 8 – Pedestrians, Cyclists, Equestrians and Community Effects.

The study area encompassed all potentially affected areas of Kilkenny City and County. The study methodology involved a desk based review of all relevant publications as well as a site visit and walkover survey of the study area. The following documents and information sources were reviewed:

- Data available from the Central Statistics Office (CSO), including Census 2011.
- National Spatial Strategy for Ireland, 2002-2020.
- National Development Plan, 2007-2013.
- Kilkenny County Development Plan, 2008-2014.
- Kilkenny City and Environs Development Plan, 2008-2014.
- Kilkenny City Centre Local Area Plan, 2005.
- www.kilkennytourism.ie
- Fáilte Ireland South East Regional Tourism Plan, 2008-2010.

6.3 The Existing Environment

6.3.1 Land Use and Settlement Structure

Land Use and Zoning Objectives

The land use pattern of lands traversed by, or located in close proximity to the proposed Scheme, comprises of agricultural land.

Zoning objectives for Kilkenny City and Environs are contained in the Development Plan for Kilkenny City and Environs (2008-2014), which is reproduced in Figure 6.1. Within the plan, the proposed Scheme is shown, and some of the land directly south of the Scheme is zoned for development. Land to the north of the Scheme, and some of the land to the south, is not zoned.

Local Economy and Employment

In Kilkenny City and Environs there were 12,499 persons aged 15 years and over in the labour force and of these, 78.7 per cent (9,838 persons) were at work. The unemployment rate for this area was 21.3 per cent compared with a national average rate of 19.0 per cent. Of the 7,054 persons aged 15 years and over who were outside the labour force, 28.1 per cent were students, 23.0 per cent were looking after the home/family and 36.4 per cent were retired. Of the 9,838 workers enumerated in this area, 2,767 worked outside the area. The daytime working population (resident and non-resident) of this area was 12,547 with commerce and trade being the largest industry.

The most popular means of travelling to work was by car (driver) with this mode accounting for 60.7 per cent of all journeys. 117 persons commuted using public transport (bus or rail). The average journey time was 21 minutes and 16.0 per cent of workers faced a commuting time in excess of 30 minutes.

In County Kilkenny there were 46,265 persons aged 15 years and over in the labour force and of these, 80.6 per cent (37,273 persons) were at work. The unemployment rate for this area was 19.4 per cent compared with a national average rate of 19.0 per cent. Of the 27,954 persons aged 15 years and over who were outside the labour force, 27.6 per cent were students, 25.9 per cent were looking after the home/family and 34.8 per cent were retired. Of the 37,273 workers enumerated in Kilkenny, 9,054 worked outside the area. The daytime working population (resident and non-resident) of Kilkenny was 27,485 with commerce and trade being the largest industry.

In County Kilkenny the most popular means of travelling to work was by car (driver) with this mode accounting for 64.9 per cent of all journeys. 444 persons commuted using public transport (bus or rail). The average journey time was 24 minutes and 18.8 per cent of workers faced a commuting time in excess of 30 minutes.

Local Business

Kilkenny County Council contains a wide range of retail outlets, facilities for financial and related services, bars, restaurants, hotels, bed and breakfasts and civic amenities. Much employment in the City has built up around the tourism trade with many arts, crafts and design showrooms and tea-rooms established in the City.

The proposed Scheme bounds the zoned Kilkenny City and Environs land, and is approximately 1km from the Borough boundary and 2.5km from the 'Core Retail Area' of Kilkenny City. Aut Even Hospital and St Luke's Hospital are large employers located close to the proposed Scheme.

Tourism

In recent years, tourism has developed as one of the major economic bases for Kilkenny City. As outlined in statistics provided by Fáilte Ireland, the south east region of Ireland, which includes Kilkenny, continues to attract tourists, with a total number of 2,086,000 visitors in 2011.

The tourist potential of Kilkenny focuses sharply on its distinctive architectural and historic heritage. The tourist resources of Kilkenny can be summarised as follows:

- The overall character of the City and in particular the heritage townscape of the historic centre.
- Kilkenny offers a unique selection of historic sites and buildings from the 7th century onwards reflecting a tradition of monastic settlement, and has a number of high quality buildings of historic and architectural significance such as Kilkenny Castle, St Canice's Cathedral, Rothe House, St Francis Abbey and Black Abbey.
- The City is compact enough for tourists to explore on foot.
- The natural beauty of the River Nore Valley.
- The services provided in the City hotels, guesthouses, restaurants, shops, design centre, theatre, galleries and cultural events.
- The reputation of the City for arts, culture and crafts.

It is a specific tourism objective of the Kilkenny Local Authorities to promote and encourage tourism development, and to facilitate improved access to and from the City and Environs.

Community Services, Activities and Recreational Facilities

The following community and recreational/sporting activities are located within approximately 1km of the proposed Scheme:

- Schools:
    - Kilkenny College
- Hospitals:
    - Aut Even Hospital
    - St Luke's Hospital
- Churches,
- Employment Related Services,
- Community Facilities,
- Recreational Facilities:
    - Kilkenny Golf Club

6.3.2 Travel Times and Community Severance

Travel Times for Car Owners, Pedestrians, Cyclists

Approximately 90% of trips generated within Kilkenny City have origins or destinations in the City. Consequently, journey speeds are slow through the City, and delays are frequent, particularly in peak times. The existing footpaths are crowded and narrow, and there is conflict between car users and pedestrians/cyclists.

Community Severance

There is currently limited access from the east to the west of the City Centre given that the two existing bridge crossings (Green's Bridge and John's Bridge) are at capacity for vehicular traffic, and do not have appropriate pedestrian and cycle access. In addition, there is also currently a perceived severance of communities, due to the high traffic volumes arising within the City Centre, which causes congestion during peak hours on weekdays and on Saturdays.

6.4 Potential Impacts of the proposed Scheme

6.4.1 Construction Impacts

Land Use and Settlement Structure

There are no direct impacts on buildings. The proposed Scheme impacts only on agricultural land. The route runs at the extent of zoned land within Kilkenny City, and along the boundary of existing development. There are no existing residential or other developments, except for one off houses, outside the boundary of the road. Direct impacts on land use will be dealt with in detail in Chapter 14 – Material Assets.

Local Economy and Employment

Impacts to activities that will be directly affected in terms of land take are addressed in terms of land take are addressed in Chapter 14 – Material Assets.

The entrance to one farm (including a residential houses and farm buildings) will experience disruption during construction, however, if the permanent new entrance is constructed prior to the main road works commencing, this disruption will be minimal. Access to a number of fields will be disrupted during construction but measures will be taken to ensure this disruption is minimal.

There may also be indirect disruption to local residents during the construction phase, arising due to traffic restrictions which may be necessary during certain times of construction such as the sequencing of the construction of the Bleach Road underpass, delivery of construction materials, etc. However, such impacts will be short term and temporary in nature, and mitigated as much as possible. Mitigation measures in this regard are outlined in Section 6.5.

Construction of the proposed Scheme will provide a positive impact on employment in the locals area through the generation of jobs within the construction sector, and local businesses and services are expected to experience increased turnover from the supply of goods and services.

Tourism

As the works will take place predominately on a green field site, it is not envisaged that visitors will be aware of the construction works, and the works should in no way deter visitors from visiting Kilkenny's tourist attractions.

Community Services and Recreational Activities

As the works will take place predominately on a green field site, it is not envisaged that they will significantly impact on community services and recreational activities in the area. However, sections of the river bank on either side of the River Nore will be closed off for the duration of the construction period to facilitate the construction of the proposed River Nore bridge

Travel Patterns

Disruptions to road users are described in Chapter 4.0, Section 4.9, Construction.

6.4.2 Operational Impacts

Local Economy and Employment

The landowners that are directly affected by the proposed Scheme in terms of land take are addressed in Chapter 14 – Material Assets.

The proposed Scheme will provide essential infrastructure to service planned commercial and business developments within Kilkenny City Centre. This will serve to provide future employment opportunities for the City and will ensure that Kilkenny City Centre can continue to operate as a vibrant and viable City Centre.

Traffic flows in the City Centre, including Green's Bridge and John's Bridge, will experience significant reductions when the proposed Scheme is in place. The Scheme will facilitate the future implementation of HGV bans within the City. In addition, the Scheme will provide improved access to the City for vehicles, and provides a pedestrian and cycle route that can be used for local access. The reductions in traffic levels in the City Centre will also ensure a more pedestrian friendly environment. Overall, the proposed Scheme will result in a more attractive and safer environment for locals and visitors, with a more effective and efficient transport system, which will encourage visitors to return to the area, and locals to stay local, ensuring the viability of Kilkenny City as a busy urban centre.

The impact on business and economic activity overall is expected to be positive, developing from improved accessibility within the City Centre, and the relieving of the historic City Centre streets of much vehicular traffic.

Tourism

It is considered that the proposed Scheme will have a positive impact on tourism. The reduction in traffic in the City Centre will make it a more attractive location for tourists. The route is a further link between the south-east and the north-west, which is a busy tourist route, and would help to ensure Kilkenny is a target location for tourists, rather than a congested area that they avoid.

Community Services and Recreational Activities

There will be no long term negative impact on any community services and recreational activities.

The provision of a dedicated off-road cycle and pedestrian facility along the length of the Scheme, adds to the existing service on the existing Ring Road, which is currently widely used for recreational walking and cycling. Pedestrian access to the proposed road will be provided to the City side of the Bleach Road. The underpass along the line of the existing Bleach Road will be for the use of pedestrians, cyclists and local cars. A walking route along the western bank of the River Nore will not be impacted on by the Scheme.

Travel Times

The proposed Scheme will lead to the re-routing of some existing journeys; however, no adverse impacts to travel times are envisaged. The proposed Scheme will generally improve journey times within the City. The Bleach Road will form a t-junction with the new road on the country side, which will marginally increase the distance for residents of the Bleach Road when they are travelling into the City. However, the new road will be a much safer and more efficient route into the City.

Community Severance

Community severance can be defined as the separation of residents from facilities and services they use within their community caused by new or improved road or by changes in traffic flows.

The proposed Scheme will serve to increase the connectivity between communities located to the east and west of the River Nore by offering an additional crossing point, with dedicated pedestrian and cycle access. In addition, it will also reduce the level of traffic on the existing bridges and will facilitate the policy of Kilkenny County Council to improve pedestrian accessibility, reducing community severance.

An underpass will be provided at the location of the existing Bleach Road. The Bleach Road will form a t-junction with the new road on the country side. Residents on the city side of the Bleach Road will

be able to access the proposed road via an underpass, which will form a t-junction with the access road to the proposed road. Residents on the country side of the proposed road will be able to access the city via the Bleach Road underpass. The Bleach Road underpass will only have sufficient height for cars, pedestrians and cyclists, and will be intend for local use. The new road will be a safer and more efficient route into the City.

Travel Patterns

The Scheme will have a positive impact on travel patterns as it will provide an alternative route across the River Nore, avoiding the two existing City Centre bridges. Traffic from the M9 will be able to reach the M7 without travelling through Kilkenny City Centre.

6.5 Mitigation Measures

Construction Phase Mitigation Measures

The following construction phase mitigation measures will be put in place:

- The EOP will include measures for the provision of information to the public, communication and complaints procedures, maintenance of access, and traffic management procedures. This will serve to minimise potential impacts on existing commercial activities, tourism and residential areas.
- Local businesses and residents will be informed in advance of the date of commencement of construction works and will be provided with information on the intended construction programme where appropriate.
- A Traffic Management Plan will be included in the EOP as part of the implementation of the Mitigation Strategy. Traffic management measures will be undertaken in compliance with any relevant authorities including the Gardai. Information on alternative access/traffic arrangements will be provided to local residents and land owners in advance of construction commencing.
- Access to farm land and private properties will be maintained at all times during the construction phase, and temporary accesses and appropriate signage etc. will be put in place.

Operation Phase Mitigation Measures

The following operational phase mitigation measures will be put in place:

- The existing road network will be maintained and retention or provision of alternative access if necessary will be made to all landholdings affected.
- Cycling and pedestrian facilities will be provided along the length of the proposed Scheme, which will tie-in to the services on the existing Ring Road.
- Relevant tourism signage will be provided along the proposed Scheme.

6.6 Residual Impacts

It is considered that the improved accessibility within Kilkenny City as a result of the Scheme will lead to an overall beneficial impact in terms of local communities and businesses.

6.7 Interaction and Inter-relationships with other Environmental Effects

Impacts on Human Beings will interact and/or interrelate with:

- Water: There will be no adverse impacts to users in terms of water quality or water supply as described in Chapter 9 – Soils, Geology, and Hydrogeology.
- Air: Exposure to wind blown dust, other particulates and emissions of pollutants from the construction phase and road traffic are important considerations abatement measures described in Chapter 10 are important to ensure residents have a pleasant and safe living environment.
- Noise: Abatement measures to reduce the impact of noise on nearby residents during the construction and operational phases of this project are discussed in Chapter 11.
- Landscape: Careful consideration to avoid impact on residential property through landscape proposals set out in Chapter 12 will be an important aspect of this project.
- Material Assets: Compensation payments for lands to be acquired as a result of the proposed Scheme will be agreed with the relevant landowners and Kilkenny County Council. The issue of the impact on landowners is addressed in detail in Chapter 14 – Material Assets.

6.8 Monitoring

Monitoring of the impacts of the Scheme on human beings will be undertaken by Kilkenny County Council through the receipt of feedback on the development from the Elected Members of Kilkenny County Council and from the public.

6.9 Reinstatement

Not applicable.

6.10 Difficulties Encountered in Compiling this Information

No difficulties were encountered.

7.0 FLORA AND FAUNA

7.1 Introduction

This chapter is an ecological assessment of the possible ecological impacts of the proposal for the Kilkenny Northern Ring Road Extension between the N77 (Castlecomer) and the R693 (Freshford) roads. It follows on from the Constraints and Route Option Study. It should be read in conjunction with Natura Impact Statement, given in Appendix H.

The assessment takes account of the NRA guidelines for road scheme planning (Guidelines for Assessment of Ecological Impacts of National Road Schemes) and relevant Irish and EU legislation, namely the Wildlife Acts 1976 – 2010 and the EU Habitats and Birds Directives and ensuing regulations and statutes.

It is derived from literature study and discussions with the National Parks & Wildlife Service and with Inland Fisheries Ireland. Two main sessions of fieldwork were carried out, one in March (2008) which was related to the constraints study and one in February 2013 for a re-assessment of bat and other habitat. The western part of the area was also visited in 2011 for another project.

The Chapter also examines the possible ecological impacts of the proposed Kilkenny Northern Ring Road Extension through two Natura 2000 sites – the candidate SAC of the River Barrow & River Nore (Site Code 2162) and the Special Protection Area of the River Nore (Site Code 4233).

7.2 Description of Site

The habitats (following Fossitt 2000) that occur in this section of the floodplain and adjacent river valley are described in detail by the March 2008 study and have not changed appreciably since then. Broadly they comprise a large area of improved agricultural grassland and smaller sections of wet woodland, dry deciduous woodland, lowland river, drainage ditches and treelines/hedgerows. Small areas of buildings and artificial surfaces are provided by the roads and trackways while there is also a little disturbed ground just west of the existing roundabout on the N77. The more interesting plant and animal species that occur are noted below.

Improved agricultural grassland (GA1)

The fields are intensively managed for grazing and some are also cut for silage. The plant species are restricted by this management and there is little if any influence of the adjacent river as the local gradients ensure that even when flooded the ground drains evenly. A former spring and wetland was drained in recent years and the only lingering effects are in the drains at the sides of the Bleach Road.

Hedgerows (WL1) and treelines (WL2)

The field boundaries include electric fences, with or without hedgerows of hawthorn, willows and bramble Rubus fruticosus. Two notable hedgerows just north of the Weir estate are the remaining edges of a patch of woodland shown on the O.S. maps and involve a broader selection of trees including oak, and hazel. The hedge along the western side of the Bleach Road is largely of elm.

Wet woodland (WN6)

A small area of wet woodland occurs at the eastern end of the route. Its type wet willow-alder-ash woodland defines the species content which includes three different willows as well as guilder rose *Viburnum opulus*. The ground in open places is covered by a good variety of tall herbs.

Swamps (FS1)

A small stand of tall sedges occurs at the eastern edge of the floodplain on the path of Route 1 where several other depressions occur related to the glacial terrain. There is also swampy ground along the northern edge of the wet woodland.

Mixed broadleaved woodland (WD1)

Deciduous woodland which has a planted origin occurs along the south-west bank of the River Nore below Auteven Hospital but is largely avoided by the routes.

River (FW2), streams and drains (FW4)

The most important watercourse in the area is the River Nore which is crossed by all routes options. It is here at the western edge of the floodplain so has a low eastern bank of 1m or so but a much higher western bank, up to 4m. An open line of trees grows on both sides of the river with ash, alder and willows.

The other watercourses have been artificially straightened so correspond to drainage ditches. Most of them have tall and nutritionally-enriched marginal vegetation though those along the Bleach Road are less modified and hold some aquatic plants.

Built land and roads (BL3)

Apart from the existing N77 and R693 roads there are a number of laneways and tracks as well as the former Castlecomer railway line at the eastern end. Adjacent buildings consist of a hospital complex, one-off dwellings, derelict/disused cottages, farm buildings and culverts.

Disturbed ground (ED)

Disturbance of sandy material on the western side of the former railway line has provided a site for ruderal, opportunist plants.

7.2.1 Flora

Pockets of interesting habitat occur along the route with plant species that are uncommon locally, though none of them are rare or protected. Starting from the eastern end, a patch of disturbed ground supports hawkweed ox-tongue *Picris hieracioides*, an introduced, but Kilkenny, speciality. The wet woodland in its clearings and drains has large sedges (*Carex acutiformis*, *C.riparia*, *C.otrubae*) as well as herbs like yellow loosestrife *Lysimachia vulgaris* and the floating liverwort *Riccia fluitans*. The large pond sedge *C.riparia* also occurs in the isolated floodplain marsh (touched by Route 1) with the introduced garden angelica *Angelica archangelica*, which is restricted to the Nore in southern Ireland.

Another centre of interest is the drain along the western side of the Bleach Road where creeping jenny *Lysimachia nummularia* is abundant. The Nore banks have patches of creeping yellowcress *Rorippa sylvestris* but this is ubiquitous along the channel, if rare over much of the country.

7.2.2 Fauna

The only large mammal dependant on the area is the otter and the species is relatively common in that a regular otter path is seen on some of the Nore bank. Feeding activities may take animals into the drains and woodland east of the Bleach Road, especially in spring when looking for frogs. Otters breed in holes in riverbanks, often under fallen trees but there are no especially favourable sites in this section of the Nore.

Badgers are resident or at least regular in the woodland on the southwest bank of the river, visiting the fields north of Auteven. No evidence of them crossing the route was seen but this is likely to happen when feeding demands it.

The bat survey (see Appendix I) indicates that at least six species occur in the area with the river channel being the most valuable habitat, followed by the riverside woodland east of Auteven and the wet woodland at the eastern edge. There are no buildings potentially affected by the project that would be suitable as breeding roosts. Temporary roosting does also occur on trees during summer, especially if ivy-covered.

The floodplain of the river attracts wildfowl when flooded and small flocks of whooper swans occur for short periods in some winters. Geese, probably grey-lag, have also been seen but very rarely. Considerable numbers of snipe feed in wetter areas of the floodplain in winter and some are likely to nest in the marshland west of the routes. Little egrets also occur sporadically along the river but do not nest. A species that has nested is the yellowhammer, seen in the hedges along the Bleach Road.

The Nore river supports a wide variety of fish, both salmonids and coarse types like perch and pike. It is a migratory route for salmon and river lamprey and there is some breeding in this section. Lamprey

larvae are found in muddy embayments along the bank. Some salmonid fry also penetrate into the drains leading to the river.

7.3 Designated Conservation Areas

The aerial photograph (Chart 7.01) shows the ecological designations in force at present. It may be seen that the river course is an SPA (vertical hatching – red) and that parts of the route are cSAC's (diagonal hatching – red). These latter, in places, are enclosed or augmented by proposed Natural Heritage Areas (diagonal hatching – blue).

7.3.1 Special Protection Area – River Nore (Site Code 4233)

The SPA is designated by S.I. No. 193/2012 under the Birds Directive (1979) and later regulations. It includes the river channel and its marginal vegetation and is listed because of the occurrence of a high population of kingfisher, a bird species included in the Annex I of the Birds Directive (see site synopsis below).

The river's banks are suitable for nesting by this species in many places while feeding occurs in the main channel and also inflowing streams and drains.

7.3.2 Special Area of Conservation – River Barrow & River Nore (Site Code 2162)

This river system has considerable European value for rare habitats and species. The site synopsis (see below) indicates that it is selected for a number of habitats in Annex I of the EU Habitats Directive - alluvial wet woodlands and petrifying springs (both priority habitats) and also for old oak woodlands, floating river vegetation, estuary, tidal mudflats, *Salicornia* mudflats, Atlantic salt meadows, Mediterranean salt meadows, dry heath and eutrophic tall herbs The site is also selected for the following species listed on Annex II of the same directive - sea lamprey, river lamprey, brook lamprey, freshwater pearl mussel, Nore freshwater pearl mussel, freshwater crayfish, Twaite shad, Atlantic salmon, otter, the snail *Vertigo moulinsiana* and the plant Killarney Fern.

7.3.3 Dunmore Complex pNHA (Site Code 1859)

This area, being a proposed NHA, does not have any statutory protection and has been modified in the years since its mapping by quarry works and agriculture. The particular part near to the eastern end of the route (alongside the old railway line now used as an avenue to a farm) has been totally reclaimed to ryegrass pasture and has no ecological importance. Another section, including the isolated floodplain marsh and westward to the Bleach Road has been partly reclaimed in the same way.

7.4 Designated Features Present in the Vicinity

Habitats Directive		Extent
Eutrophic tall herbs	Annex I	Fragments in wet woodland
Otter	Annex II	Frequent along river
Atlantic salmon	Annex II	Frequent in river
River lamprey	Annex II	Frequent in river
Brook lamprey	Annex II	Possible in drains
Freshwater crayfish	Annex II	Frequent in river
Birds Directive		
Whooper swan	Annex I	Occasional on floodplain (winter)
Peregrine	Annex I	Regular feeding (aerial)
Kingfisher	Annex I	Frequent along river
Golden plover	Annex I	Occasional on floodplain (winter)
Wildlife Acts 1976-2010		
Bat species (also in Annex IV, Habitats Directive)		Common & soprano pipistrelle, Leisler's, Daubenton's, brown long-eared, Natterer's, whiskered.
Hedgehog		Eastern end, hedges and dry ground
Badger		Regular on west side of river valley
Stoat		In cover of trees/hedges
Pygmy shrew		In cover hedges, scrub
Common frog		Breeds in drains, feed in wet ground
Common newt		Probable in drains
Birds (except pest species)		

7.5 Effects of Development

The only unavoidable consequences of the project are the covering up of habitat inside a Natura 2000 site and the creating of noise and a level of air pollution that has not been present before. All other effects may be mitigated by attention to detail in design and construction.

7.5.1 Habitat Loss

The road will run for 173m through the cSAC, made up of 67m at the eastern end, 44m beside the Bleach Road and 62m in crossing the river. The comparable distance through the SPA is 22m, the width of the river channel itself.

The section at the eastern end consists first of a drain beside the old railway embankment, then the embankment itself which carries a farm access, then a section of fill which is grassed on the slope

down to the stream at the base. Here there is a broad drain which floods back from the river during high water conditions. Two young crack willow *Salix fragilis* and a few grey willow *Salix cinerea* grow in and around a stand of pond sedge *Carex riparia* in the deeper water. Meadowsweet *Filipendula ulmaria* and marsh valerian *Valeriana officinalis* grow in the vicinity. The northern side of this drain is now improved grassland though it was included in a proposed Natural Heritage Area (see map at end).

At the Bleach Road the route enters the tip of a triangular grassland field which is cut for silage, At the northern end there is a mixed stand of rough-stalked meadowgrass *Poa trivialis* and ryegrass *Lolium perenne* which include a lot of meadow foxtail *Alopecurus pratensis* towards the river.

Improved grassland extends almost to the riverbank at the bridge crossing point except for a line of osier *Salix viminalis* and one white willow *Salix alba* with a scatter of. cow parsley *Anthriscus sylvestris* and celandine *Ranunculus ficaria* in between. The river channel is deep though stony with some algae. The western bank is higher (4-5m) than the east and fenced off from animals so has an intact, scrubby fringe including bramble *Rubus fruticosus*, gorse *Ulex europaeus*, blackthorn *Prunus spinosa*, privet *Ligustrum vulgare* and a little guelder rose *Viburnum opulus* with trees growing above it. On this side English elm *Ulmus procera*, white willow *Salix alba* and sycamore are noticeable and the herbs include false brome *Brachypodium sylvaticum* and lords-and-ladies *Arum maculatum*. A small patch of gorse scrub also covers the valley side in the cSAC adding hard rush *Juncus inflexus*, primrose *Primula vulgaris* and barren strawberry *Potentilla sterilis*.

None of these areas has significant ecological interest and the plant species are widespread in the river valley. In particular there are no areas of Annexed habitat and no protected plants under national legislation.

7.5.2 Other Impacts

These impacts are general to road projects and are not specific to the Natura 2000 sites.

Severance

This is probably most important for mammals which move extensively during feeding such as bats, badgers and otters. Many species of bats are unwilling to cross open spaces due to fear of predation, and may have their feeding territories greatly reduced by road gaps. Wider gaps are the most serious but bridging trees can often be used in mitigation. Most species can be considered to cross an open space the same length as the height of the adjacent trees.

Lighting also may constitute a barrier particularly to bats as some species will not cross a lighted area. Daubenton’s bat on the river is the most sensitive but it applies to all species. Down-lighting will be important in any habitat of value to bats.

Few otter (or badger) movements occur on the floodplain fields but the frequent openings for water flow will facilitate animal movements provided they are not fenced. A study of badger movements in the field around Auteven should be done to allow for an underpass somewhere on this section.

The bridge itself is a potential barrier but this will be much reduced by having the span high enough over the water to allow swans etc to fly underneath and also to have the free space on each bank to allow for continuous vegetation especially of shrub height. Too narrow a gap promotes muddy ground as animals and fishermen create a path.
Culverts can create a significant barrier on streams and drains that are crossed and care must be taken to make them fully passable by fish, particularly as some salmonids are found in drain son the floodplain.

Disturbance

Disturbance in terms of noise seems seldom to be an issue for wildlife and is much more noticed by people. Four of the species of importance are aquatic so cannot be affected by noise. Otters and kingfishers are tolerant and much more controlled by the presence of food and shelter. Both species are seen in towns quite frequently if water quality is good.

The main disturbance during the construction phase is site clearance and the removal of tree or bush cover. The movement of machinery on the embankment or at the river side will not be significant although it may alter the daily behaviour of some species.

Air pollution

Raised levels of nitrogen oxides are experienced by all road verges with a reasonable amount of traffic and these might be considered to impact on the vegetation of the cSAC (see Air Quality and Climate section of EIS). However, a floodplain is a nutrient-rich habitat, a situation produced by river flooding and, in this case, intensive management of the grassland over most of the adjoining area. Additional nitrate input will not be significant in this case.

Positive impacts

The extensive embankment will allow for an ecological type of management that could favour plant communities and insect life in places where the current intensive agriculture prohibits them. This will depend on the type of material used but should be considered at an early stage with the aim of offsetting some of the negative effects of the project in the cSAC.

7.6 Mitigation Measures

The effect of site clearance, cut and fill and general traffic movements are recognised as major factors in releasing sediment that can feed into the river to the detriment of most forms of aquatic life and especially salmonid fish. Method statements will be prepared by the contractors to cover all activities,

with sufficient settlement and run-off capacity to minimise this risk. Building the embankment progressively from one end to the other will minimise this potential impact as will the naturally low gradients of the floodplain.

7.6.1 Water Quality

In designing appropriate mitigation measures to safeguard water quality in the river the requirements of Inland Fisheries Ireland (see Appendix C) will be met, i.e.

- Silt traps/settlement ponds or other forms of containment and treatment shall be constructed at locations that will intercept run-off to streams. Traps shall not be constructed immediately adjacent to natural watercourses. A buffer zone should remain between the silt trap and the watercourse with natural vegetation left intact. Alternatively, imported materials such as terram, straw bales, coarse to fine gravel should be used either separately or in combination as appropriate to remove suspended matter from discharges.
- The level of suspended solids in any discharges to fisheries waters as a consequence of construction works shall not exceed 25 mg/l, nor result in the deposition of silts on gravels or any element of the aquatic flora or fauna.
- When cast-in-place concrete is required, all work must be done in the dry and effectively isolated from any flowing water (or water that may enter streams and rivers) for a period sufficient to ensure no leachate from the concrete.
- No direct discharges be made to waters where there is potential for cement or residues in discharges.
- Designated impermeable cement washout areas must be provided.
- The pH of any and all discharges made from and during construction works shall be in the range 6.0 - 9.0 units and not alter the pH of any receiving fisheries waters by more than +/- 0.5 pH units.
- All oils and fuels shall be stored in secure bunded areas and care and attention taken during refuelling and maintenance operations. Particular attention shall be paid to gradient and ground conditions which could increase the risk of discharge to waters.
- Temporary oil interceptor facilities shall be installed and maintained where site works involve the discharge of drainage water to receiving rivers and streams.
- There shall be no visible oil film in any discharges from construction works to waters.
- That all containment and treatment facilities are regularly inspected and maintained.
- Waterproofing and other chemical treatment to structures in close proximity to waters shall be applied by hand.
- Hydroseeding shall not be carried out in close proximity to water. These areas shall be seeded by hand.

7.6.2 Disturbance

The river banks will be checked in case of nesting kingfishers prior to construction and the bridge works timed to avoid any impact.

7.6.3 Other Mitigation

Tall growing trees will be planted close the road edge on the old railway embankment so that a flight bridge may be established with trees there. The significance of this is small as the major feeding area occurs to the south-west. However there could be some roosting by bats in the farm buildings on the northern side.

Mature trees will be left as close as practicable to the bridge on the river bank and willows will be allowed to grow under the bridge itself. This will lessen any severance effect of the bridge for bats.

7.7 Residual Impacts

The project can be completed without significant effect on the Natura 2000 sites provided the mitigation measures are effective. Local impacts will occur but these will not endanger the special features of the sites or their conservation objectives.

The project will not add cumulatively to others to create any significant impacts on the Natura 2000 sites.

7.8 Interaction and Inter-relationships with other Environmental Effects

The proposed scheme is designed to ensure water conveyance in the flood plain is maintained.

7.9 Monitoring

Not required.

7.10 Reinstatement

There is no reinstatement required.

7.11 Difficulties Encountered in Compiling this Information

None.

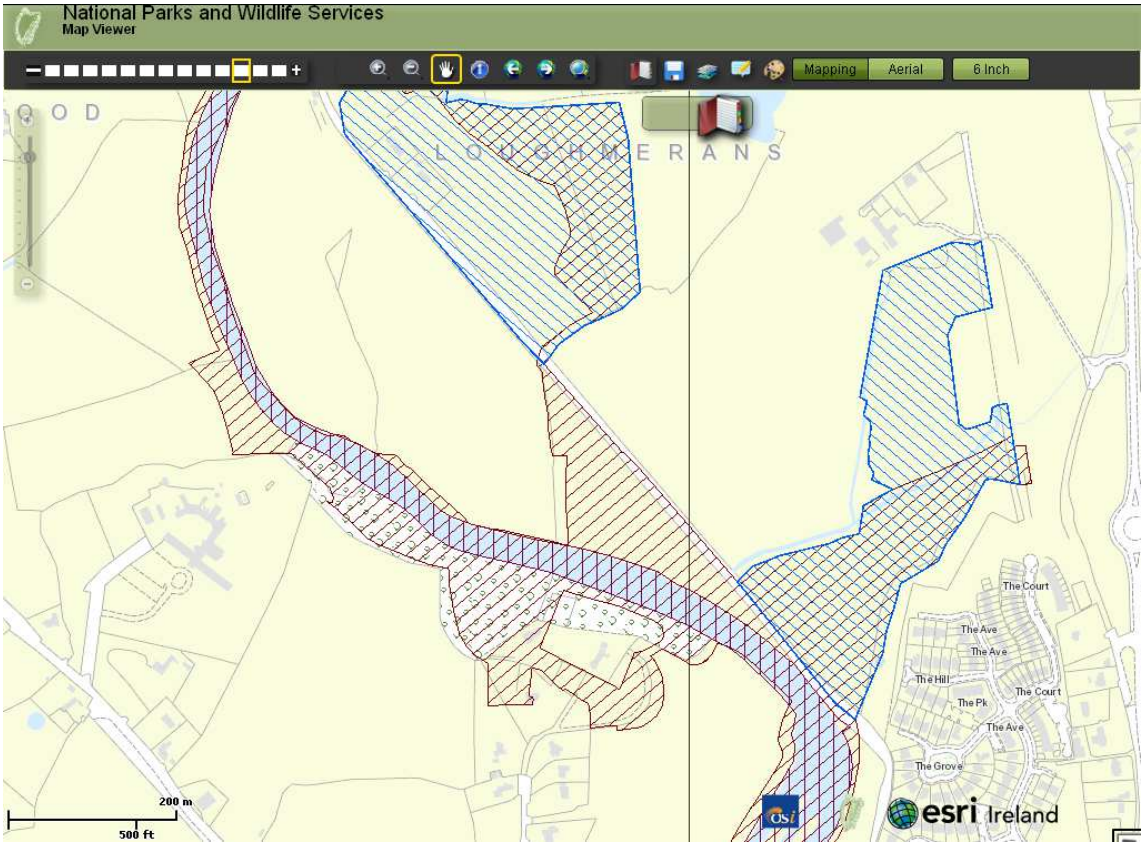


Chart 7.01 Map to show location of SPA (vertical red), cSAC (diagonal red) and pNHA (blue)

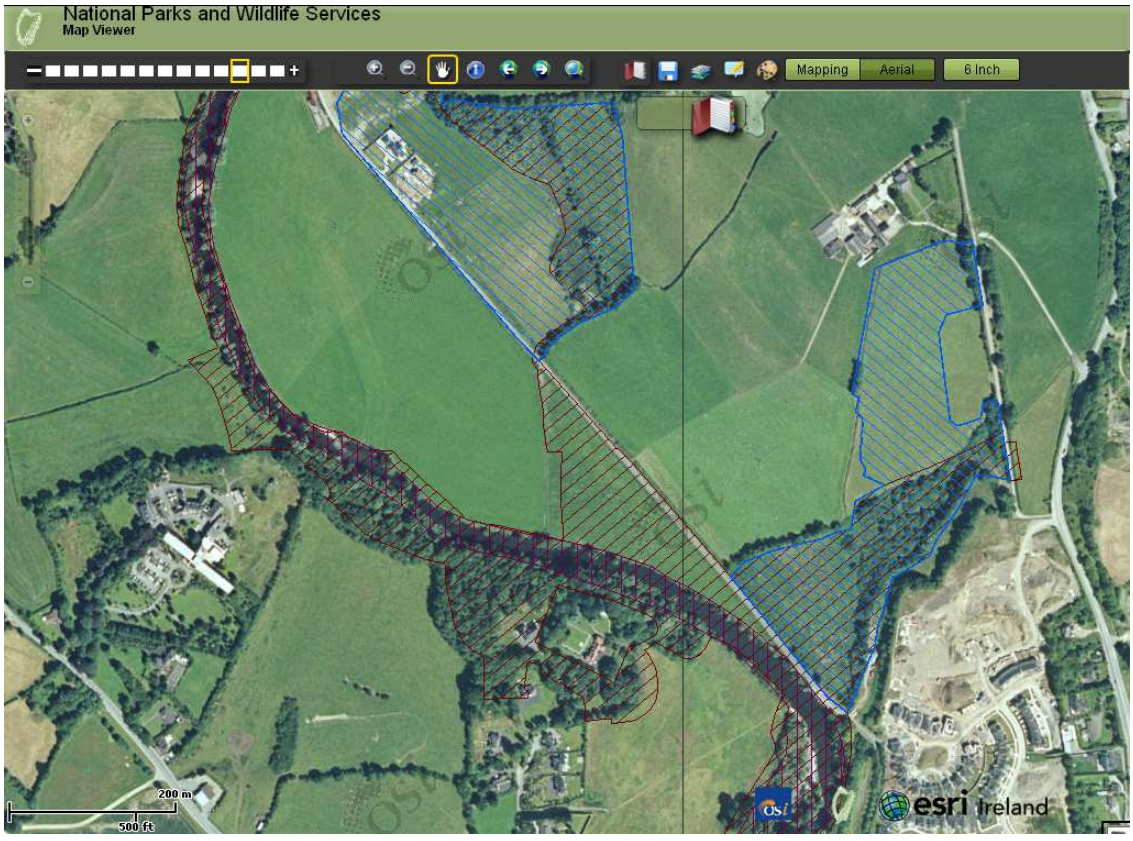


Chart 7.02 Aerial photograph with designations, illustrating habitat types crossed by route

8.0 HYDROLOGY

8.1 Introduction

As part of the EIS process, an assessment was undertaken on the potential impacts of the proposed bridge (facilitating the Kilkenny Northern Ring Road Extension from the Castlecomer Road to the Freshford Road) on the existing characteristics of river flows in the Nore upstream and downstream of where the structure is to be sited.

The location and alignment of this bridge is shown in Figure 1.02 and further details can be found in Figures 4.01 - 4.03.

The proposed bridge crosses an active floodplain of the River Nore and the hydraulic impacts of the proposed bridge linking the planned Northern Ring Road across the Nore valley are presented. More specifically, this section of the EIS aims to:

(1) Determine the design water levels upstream, through and downstream of the proposed bridge for the 100 year flood event and to determine whether, in the context of increased flood risk, these are significantly different to flood water levels that are predicted for the channel as it currently exists. Note that this 'existing condition' geometry is considered to include the new river crossing that is to be constructed approximately 120 m downstream of Green's Bridge.
(2) Determine the design water levels upstream, through and downstream of the proposed bridge for the 100 year flood event with a climate change factor and to determine whether these are significantly different to flood water levels that are predicted for the channel as it currently exists. As with (1) above, this 'existing condition' geometry is considered to include the new river crossing that is to be constructed approximately 120 m downstream of Green's Bridge.
(3) Assess whether the loss of floodplain storage from the proposed bridge and its associated embankments is significant.

The hydraulic analyses involved the generation of a series of steady and unsteady flow river profiles for specific design flows and boundary conditions using a 1-dimensional river model. The context, methodological details and results of this analysis are presented in subsequent sections.

8.2 The Existing Environment

8.2.1 River Nore Catchment

The River Nore has its source about 5 km west of the N62 at a point mid-way between Roscrea and Templemore in Gorteenashingaun, a minor mountain north-east of Benduff mountain. The Nore then flows for approximately 27 km in a north-east direction towards Mountrath and from here flows in a south-east direction until its confluence with the Barrow upstream of New Ross. The Nore is 143 km

long making it one of the longest rivers in the country and its catchment covers 9205 km^2 to its confluence with the Barrow.

At Kilkenny, the river's upstream catchment extends to 1605 km^2 and includes the tributaries of the Delour, Ekrina and Dinan. The Dinan is the most important in the context of flooding in Kilkenny City. Given that the area of this tributary catchment is only 298 km^2 (~ 19% of the Nore catchment to Kilkenny City), its significance in terms of flood generation lies in its mountainous topography from which rainfall produces 'flashy' floods. The capacity of the Dinan catchment to produce flood flows in the River Nore is contributed to by an impervious subsoil layer that extends from the Slieveardagh hills in the south-west to the Castlecomer Plateau in the north-east. The band of land from Templemore to Urlingford in the south-west to Portloaise and Abbeylix in the north-east also suffers from poor drainage. Groundwater influences (seepage outbursts and springs) in the north part of the contributing catchment from Templemore across to the Slieve Bloom's and around Durrow augment the river flow.

8.2.2 Previous Flood History

Natural rivers can typically cater for low to moderate flows with more extreme events being accommodated in overbank flow and floodplain (natural attenuation areas on either side of the main channel) storage. In the past, socio-economic development was closely related to the waterways which provided many of the requirements essential for sustaining human activity. As a consequence, many Irish towns and cities, including Kilkenny, evolved from small conurbations on the banks and floodplains of rivers. At this time, the impact of flooding was a minor nuisance but as development continued, problems relating to both the river environment and flooding increased.

The long flood history of flooding in the River Nore and in Kilkenny City has been provided in the Engineering Report of the Kilkenny Flood Relief Scheme (OPW, 1999). The magnitude of these floods is large and they rise and fall more rapidly that would be expected for a river of its size in Ireland. Although no flood level information is available for the event, the most notable flood in Kilkenny City is thought to have occurred on the 2nd October 1763. Written reports indicate that all bridges with the exception of Ballyraget Bridge were destroyed and the lives of those viewing the flood from John's Bridge were lost. Other significant floods occurred in November 1787 and September 1797 as well as in March 1947. Given that the 1947 flood occurred in living memory, the event has added significance for flood assessment as reliable accounts of the flood levels reached by flood waters along the channel are available. Many other significant flows that produced wide scale flooding in Kilkenny City and/ or its surrounds the River Nore have also been observed. These included those in 1954, '60, '68, '79, '84, '86, '90, '95 and '97. The 1968 flood is the largest to occur since 1947.

Flood defences were implemented in 2004 for Kilkenny City as part of the River Nore Drainage Scheme which was funded by the Office of Public Works (OPW) and although very significant flows that resulted in flooding in areas around Kilkenny have occurred since, the city itself has not been

inundated. The OPW maintain a gauge at John's Bridge in Kilkenny City (Station 15002 in national hydrometric network) and estimated[1] discharges for the more significant flows in the River Nore that were recorded before and after the construction of the flood defences are summarised in Table 8.2 and Table 8.3 respectively.

Table 8.1 – Notable flows in River Nore prior to 2004 (OPW, 2013)

Date	25/12/'68	27/12/'79	16/01/'84	26/08/'86	06/02/'90	27/01/'95	18/11/'97	06/11/'00
Discharge (m^3/s)	393	295	290	281	299	297	281	274

Table 8.2 – Notable flows in River Nore after 2004 (OPW, 2013)

Date	16/08/'08	19/11/'09
Discharge (m^3/s)	350	352

Based on reports from local residents along Bleach Road, it is highly likely that Bleach Road and the lands that separate Bleach Road from the river and where the proposed bridge is to be constructed, would have been significantly inundated for all these floods. Indeed, photographic evidence (Chart 8.01) of the flood on January 10th 2008, with an estimated peak discharge of 280 m^3/s suggests that widespread inundation to considerable depth will occur on the Bleach Road and in the river floodplains for flood discharges much lower than those in Table 8.1 and Table 8.2.

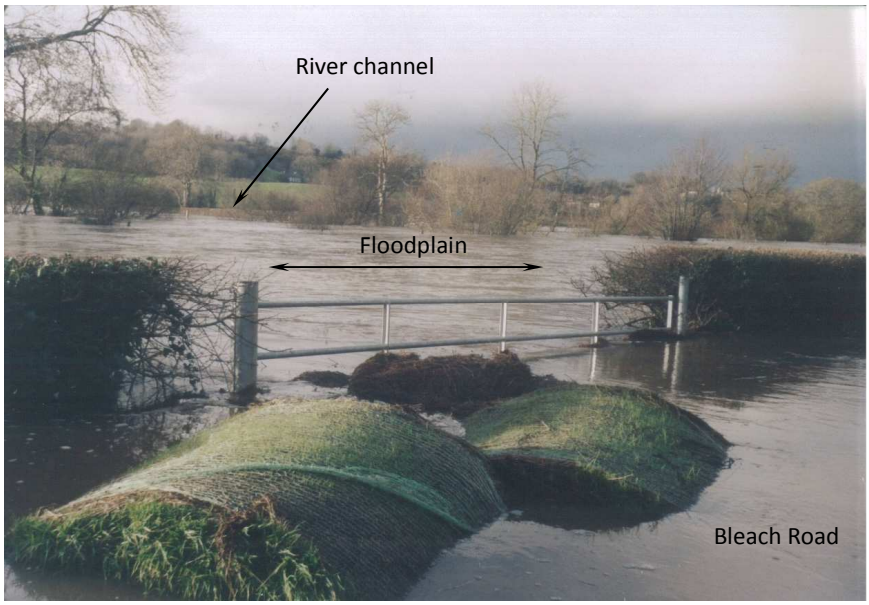


Chart 8.01 – Inundation for flood on 10th January 2008 *(photo courtesy of Brian Holohan)*

1 Estimated discharges are based on extrapolations from a measured rating. The reliable limit of the rating prior to 2004 when defence works were constructed is 233 m3/s and that of the rating post 2004 is 150 m3/s. Caution is therefore advised when drawing inferences from flow discharges that significantly exceed the reliable limit.

8.3 Assessment Methodology

Flood assessments typically require an understanding of design flood conditions, or the *Hydrology*, together with a means of assessing these design conditions in a particular river channel, referred to as the *Impacts*. For this assessment, impacts were considered for the flood with a recurrence interval of 1 in 100 years. The use of this flood is the first design standard considered by OPW for the assessment of flood impacts and Section 9.12.5 of the Kilkenny County Development Plan 2008 – 2014 stipulates its use for Urban areas or where developments (existing, proposed or anticipated) are involved. The 100-year Return Period Flood is a flood which returns on average once in 100 years or alternatively has a 1% chance of occurring in a given year.

Furthermore, it is generally accepted that climate change into the future will result in increases in winter rainfall (and decreases in Summer rainfall) with the likely consequence that peak river flows will be higher. The potential impacts of future climate change have been included in the hydraulic analysis of the proposed bridge by applying a climate change factor of 20% to the 100-year design flow. This is the approach that has been recommended by OPW.

In river systems, this additional climate change factor is accommodated by any of three design approaches recommended by OPW. These are summarised as:

Sensitivity-Guided Design: This approach requires that the sensitivity of the design of a scheme to climate change shall be tested by increasing the value of parameters that might be subject to change. This assessment should form part of the risk analysis of the various flood defence options considered and should therefore, influence the selection of the preferred scheme. However, no allowance for climate change is made in the relevant design parameters in the chosen scheme.

Design for Enhancement: Adopting this approach requires that the flood relief scheme is designed such that the defence levels or capacities could be increased or enhanced at minimum cost and impact at a future date to provide defence or adequate capacity for increased flows and/or levels, on the basis that such enhancement might be required should the impacts of the predicted climate change be realised.

Design for Climate Change: This approach requires that flood defence works are designed to cope with predicted future conditions assuming that the potential changes will be realised to a specific degree in terms of increased river flows and/or levels.

Freeboard Allowance: It is considered prudent that hydraulic structures should include a freeboard allowance over and above design flood water levels. Freeboards generally allow for uncertainties in hydrological predictions and hydraulic modelling as well as potential wave action in the river reach.

Given that any modifications to a river crossing during its operational (rather than construction) phase are difficult, the Design for Climate Change with a freeboard allowance of 0.3 m has been adopted for the proposed bridge.

The impacts of this design flow upstream and downstream of the proposed bridge crossing were assessed using the HEC-RAS (Hydraulic Engineering Centre-River Analysis system) river modelling software for a range of options in which the geometrical properties of the openings in the proposed bridge were varied. HEC-RAS is a 1-Dimensional link and node river model that computes the steady flow profiles for specified upstream flow rates and downstream water levels. The model was, and continues to be, developed by the US Army Corps of Engineers and is accepted as being the industry standard for river modelling applications of the type investigated in this EIS.

8.3.1 The HEC-RAS Steady Flow Model

The normal computational procedure of HEC-RAS for steady flow situations involves the standard-step solution of the one-dimensional energy equation for gradually varied flows. Energy losses are evaluated by friction together with the contraction and expansion losses in the river system. The momentum equation may be used in rapidly varied flow applications such as hydraulic jumps, hydraulics of bridges and for evaluating profiles at river confluences. Steady-state HEC-RAS models assume that the flood wave is kinematic and that the flood discharge will not vary with time. On typical projects, of limited channel lengths, a kinematic wave is considered appropriate.

The steady-state HEC-RAS model requires data classified in two sections, namely hydrological and hydraulic data. These are dealt with in the individual sections that follow.

8.3.1.1 Hydrological Data

Hydrologic data defines is the output response of a precipitation (storm) event to a catchment system. For the steady flow simulations in this study, the discharge magnitude corresponding to the 100 year flood was required. A flood frequency analysis was used to estimate this flood. While different approaches of flood analysis for gauged and ungauged catchments are available, an Annual Maximum (AM) analysis is preferred in Ireland when a hydrometric record from a nearby gauge is available. This is especially true for long records of flow because there is clear independence of the flood events used in the analysis. An AM series comprises the largest floods that were recorded in each Hydrometric year (Flood Year) of the record. These are the extreme floods from each year and are treated using an Extreme Value Statistical Analysis referred to as the AM analysis. For Ireland, as recommended in the 1975 Flood Studies Report, the Extreme Value Type I (EV1) distribution is used for AM data and this distribution is employed in the analysis of flood data in this EIS.

A flow gauge with a long-term record of high quality discharge data does not exist at the location of the proposed bridge. However, an OPW maintained gauge is operating at John's Bridge, in Kilkenny.

A continuous AM record, with a reliable limit of 233 m^3/s, exists for this gauge from 1966 to 2000. A frequency analysis of this data set undertaken for this study indicates that the 100-year flow is approximately 420 m^3/s. A discontinuity from 2001 to 2006 (6 years) exists in the record and a new rating with a reliable limit of 150 m^3/s established since the completion of the flood defence scheme has been used to extrapolate the extreme events for the years from 2007 to 2010. These data years complete the currently available AM record that is available from OPW (2013). A frequency analysis of the record with the additional four data years (2007 to 2010), albeit with the reduced reliable limit, yields a 100-year design flow of approximately 440 m^3/s.

However, a flow record consisting of a series of partial flow record dating back to 1926, together with more recent data from the OPW gauge at John's Bridge was assembled for the design calculations used in the developing the flood defence measures for Kilkenny. A frequency analysis of this long record that comprised both observed records and a record of historical flood peaks from 1926 to 1994 was undertaken by OPW (1999) as part of the design of the Kilkenny flood defence scheme. This analysis indicated that the 100-year flood at John's Bridge is approximately 475 m^3/s. This flow, being larger than the flows calculated from the shorter flow record currently available at John's Bridge, is used in this report. The flow includes two components: a flow in the River Nore of 440 m^3/s and a flow in the Breagagh of 35 m3/s.

A climate change factor of 20% (as required by OPW) was applied to these 100-year design flows such that for the assessment of climate induced increases in river discharge, simulations were completed with a flow on 530 m3/s in the River Nore and 40 m3/s in the Breagagh River.

8.3.1.2 Hydraulic Data

Geometrical Data

The HEC-RAS hydraulic model included a river reach that extended upstream and downstream of the bridge location. The final model used in this assessment was made up of two components. The first part was a model that extended for approximately 6 km to a point just downstream of Green's Bridge. This model was constructed with geometry inputs (channel cross-sections incorporating stream bed, channel banks and floodplains at locations within this 6 km river stem) collected specifically for this EIS. These were obtained from a detailed topographical survey of the catchment by Murphy Surveys Ltd. A total of 64 cross-sections were surveyed. The locations of these cross-sections are shown in Figure 8.01.

The second part was an existing HEC-RAS model developed by Mott McDonald EPO for the River Nore (Kilkenny City) drainage scheme. This model, referred to as cal_19.proj, extended for approximately 1 km from upstream of Green's Bridge to downstream of John's Bridge resulting in the combined model length of 7 km. It is assumed that the cal_19.proj model geometry represents the post flood defence scheme river geometry and that this has remained unchanged since 2006.

Interpolated cross-sections were included in the model when cross-sectional data was scarce or when properties between two consecutive cross-sections resulted in a change in velocity head that was too large to accurately determine the energy gradient. An adequate depiction of the change in energy gradient is necessary to accurately model friction losses along the channel as well as expansion and contraction losses between sections.

The behaviour of hydraulic structures, such as bridges and culverts, and their impact on flood processes are important in determining the backwater profiles for high river flows. In the reach of the River Nore under consideration in this EIS, Johns, Green's and a proposed new bridge are important in this regard. Consequently, detailed plan and elevation data of these structures were included for modelling purposes.

All river sections and relevant structures were imported into the river model with the correct orientation viewed from left to right bank looking downstream. All survey elevations were referenced to Ordnance Datum (OD) Malin Head.

Main Channel and Floodplain Resistance Parameters

The hydraulic roughness for the main channel and floodplains of the hydraulic model, described in terms of Manning's n, were determined from a combination of the Soil Conservation Service Method for roughness estimation in open channels as described in French (1986) and by a combination of the pictorial representations given in Chow (1956) and in HR Wallingford design guidelines (Hollingrake and Samuels, 1995). Roughness characteristics of the Nore changed along the modelled reach but main channel n values typically varied from 0.038 to 0.045. Where floodplains were characterised by grassland pasture of short and high grass, n values of between 0.03 and 0.05 were adopted.

Boundary Conditions

The final hydraulic data requirement for the steady flow HEC-RAS model was the boundary condition. While the model can be executed using a number of different boundary conditions, a known water surface elevation at the downstream extent of the model was chosen for simulations in this study. The downstream boundary of the tested model coincided with the downstream boundary of the physical model of the Kilkenny Flood Relief Scheme that was tested by HR Wallingford in 1996/ 97. The results from this physical modelling, later revised by Mott McDonald EPO, produced the downstream boundary conditions (known water level) for both the 100-year flood and the 100 year flood with climate change factor that were used in this study.

8.3.2 The HEC-RAS Unsteady Flow Model

For unsteady flow applications, HEC-RAS solves the full, dynamic, 1-D Saint Venant Equation. The unsteady flow equations are reduced to a discrete form and solved in HEC-RAS using an implicit finite difference numerical scheme. Unsteady simulations assume a dynamic (rather than kinematic) flood wave in which the discharge will vary in space and time, attenuating as it moves downstream.

8.3.2.1 Hydrological Data

Design flow hydrographs representing the output response in a catchment to a storm event were required for the unsteady HEC-RAS simulations in this study. For the purpose of this study the 15 minute flow and stage record for Hydrometric Station 15002 (John's Bridge, River Nore) from the 18th May 2006 was made available by OPW and flood hydrographs for notable events were extracted from this record. A stage-discharge rating at John's Bridge was also established from this OPW data. Furthermore, as part of this study, a flow gauge was installed at Green's Bridge. This gauge was operational since the 26th July 2010 and also provided flow data at 15 minute intervals.

The unsteady analysis required a hydrograph corresponding to the 100-year flood. The peak flow of this hydrograph at the location of the proposed bridge is approximately 440 m^3/s. In the period since May 2006, the largest recorded flow in the Nore at John's Bridge, for which flow and stage hydrographs were available, was estimated to be 352 m^3/s (albeit with a reliable limit of 150 m^3/s). Given that this is somewhat lower that the 100–year flow at John's Bridge of 475 m^3/s, a synthetic (triangular) hydrograph for the 100 – year event was developed. The hydrograph was developed in two stages. Firstly, the rising limb of the design hydrograph was constructed to be consistent with the rise of observed floods and secondly, the receding limb was estimated using the Flood Studies Report (NERC, 1975) relationship in which duration (T_B) is linked to the time to peak, T_P, as follows:

$$T_B = 2.52T_P$$

From this approach, the estimated 100-year hydrograph as shown in Chart 8.02 was developed.

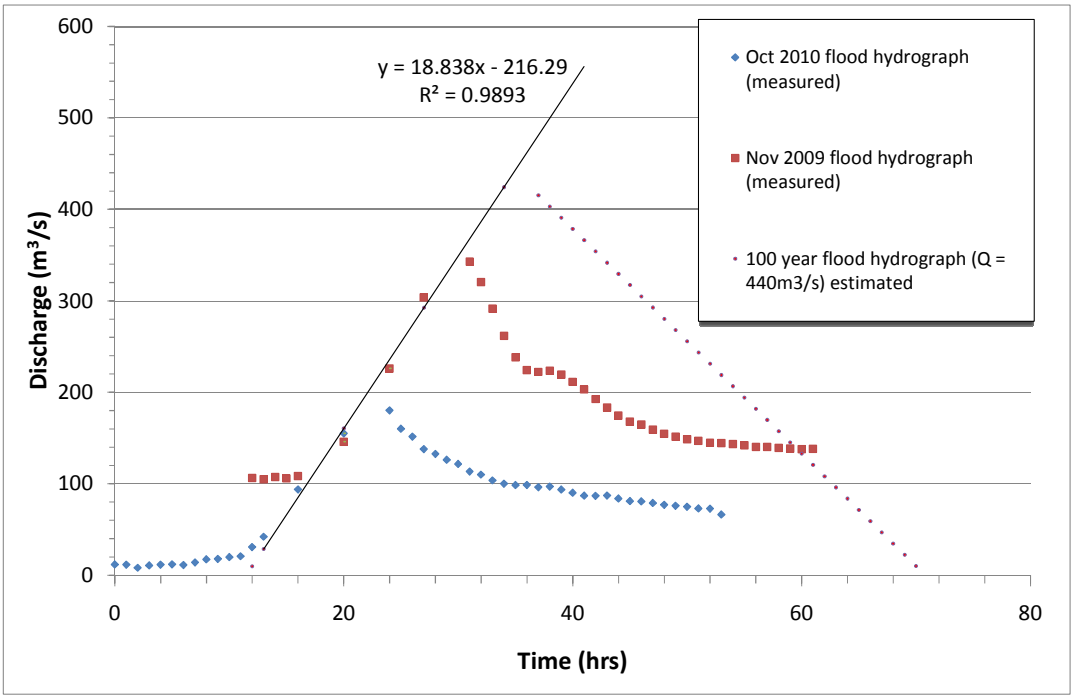


Chart 8.02 Estimated 100 year flood hydrograph used in unsteady HEC-RAS simulations

8.3.2.2 Hydraulic Data

Geometrical Data

The geometrical data (described in Section 0) used to develop the steady-state HEC-RAS model was used to construct the unsteady HEC-RAS model.

Main Channel and Floodplain Resistance Parameters

The main channel and floodplain resistances, described in terms of Manning's n and described in Section 0 were used in the unsteady HEC-RAS model.

Boundary and Initial Conditions

Unsteady HEC-RAS simulations were executed using a combination of upstream and downstream boundary conditions. Flow hydrographs of the type shown in Chart 8.02 formed the upstream boundary conditions and for these, simulations were executed using a combination of downstream stage hydrographs and rating relationships. A downstream rating relationship was developed using the OPW data from Hydrometric Station 15002 at John's Bridge.

The initial condition flow used for the unsteady HEC-RAS simulations was set to be consistent with the first time step flow of each of the input hydrographs.

8.3.3 Calibration of Hydraulic Model

At the outset of this flood study, the need for model calibration data was recognised. Ott Hydrometry Ltd were commissioned to supply, install and calibrate four automated flow level recorders and a continuously recording discharge meter at the commencement of this study. Ott Hydrometry Ltd. are world leaders in the development and supply of measuring equipment for these purposes. The locations of these monitoring stations are shown in Figure 8.01.

All stations contain an integrated data logger and power supply. In addition to these four water level recorders, a side-facing Doppler flow discharge recorder was installed at Green's Bridge.

The hydrometric monitoring suite has been functioning in the River Nore since July 2010. In the period to the present date, the highest peak flow occurred on 29th October 2010 at 9:45pm. This flow, at Green's Bridge, was measured to be 199.45 m3/s. The flow measured by OPW at John's Bridge (Station 15002) at this time was 211.975 m3/s, indicating that the Breagagh River flow was just in excess 12.5 m3/s. These flows with the corresponding measured water levels (Table 8.3) were used for calibration of the steady and unsteady HEC-RAS models.

Table 8.3 – Calibration water levels recorded on 29th October 2010

Gauge No.	Water Level (m OD Malin Head)
Gauge 4	51.27
Gauge 3	49.07
Gauge 2	47.61
Gauge 1	46.45

Calibration of the Steady State HEC-RAS Model

The steady state HEC-RAS model for calibration was executed with the input parameters in Table 8.1. The downstream boundary was defined by a known water surface elevation provided by the OPW.

Table 8.1 Input parameters for calibration of the HEC-RAS steady flow model

River Nore Discharge (m^3/s)	Breagagh River Discharge (m^3/s)	Downstream Water Surface Elevation Boundary Condition (m OD Malin Head)
199.45	12.525	42.837

Executing the steady flow HEC-RAS model for the calibration flow data in Table 8.1 yielded the flow profile shown in Chart 8.03. The 'new bridge' in Chart 8.03 refers to a river crossing that, although not yet constructed, had been approved by Kilkenny County Council. The 'EIS bridge' refers to the crossing that is the subject of this assessment.

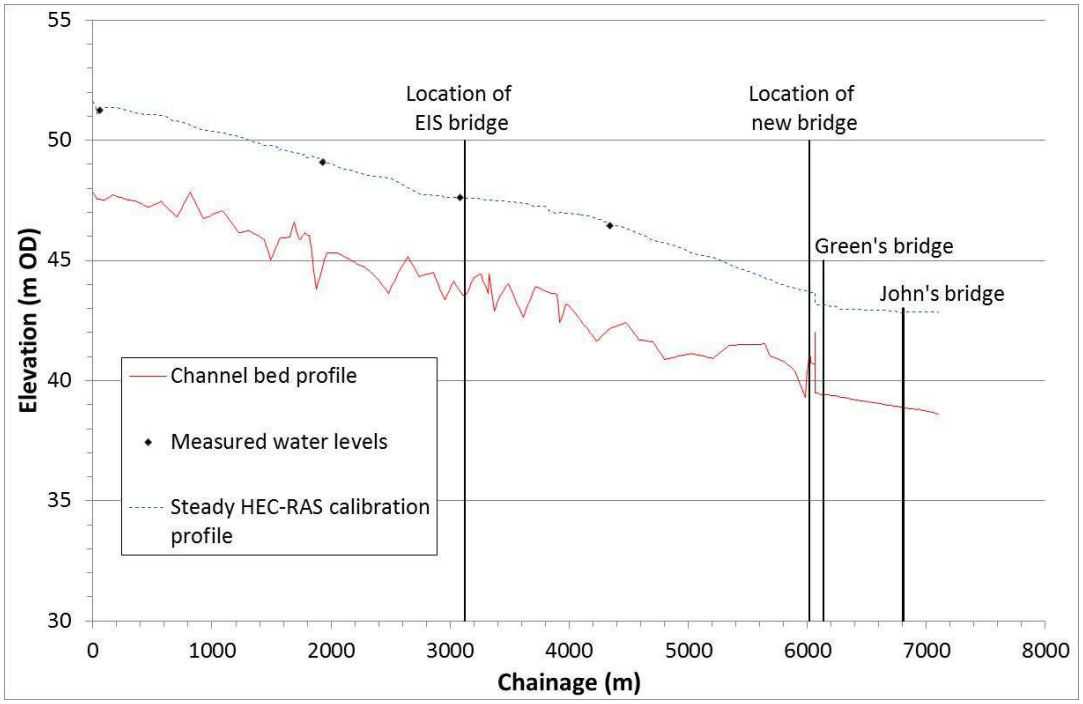


Chart 8.03 Steady flow HEC-RAS calibration profile for flood on the 29th October 2010

Chart 8.03 indicates that there is a good level of agreement between the model and measured profiles for this calibration. The consistency of the HEC-RAS profile with the measured water levels indicates a good level of accuracy and reinforces the suitability of the model for this particular application.

Calibration of the Unsteady HEC-RAS Model

The unsteady flow HEC-RAS model was executed using the October 2010 flow hydrograph in Chart 8.02 at the upstream boundary together with a rating relationship established from OPW flow and stage data at John's Bridge (Hydrometric Station 15002).

Executing the HEC-RAS unsteady model with these inputs gave the flow profile in Chart 8.04 and this also shows a good correlation to the measured water levels.

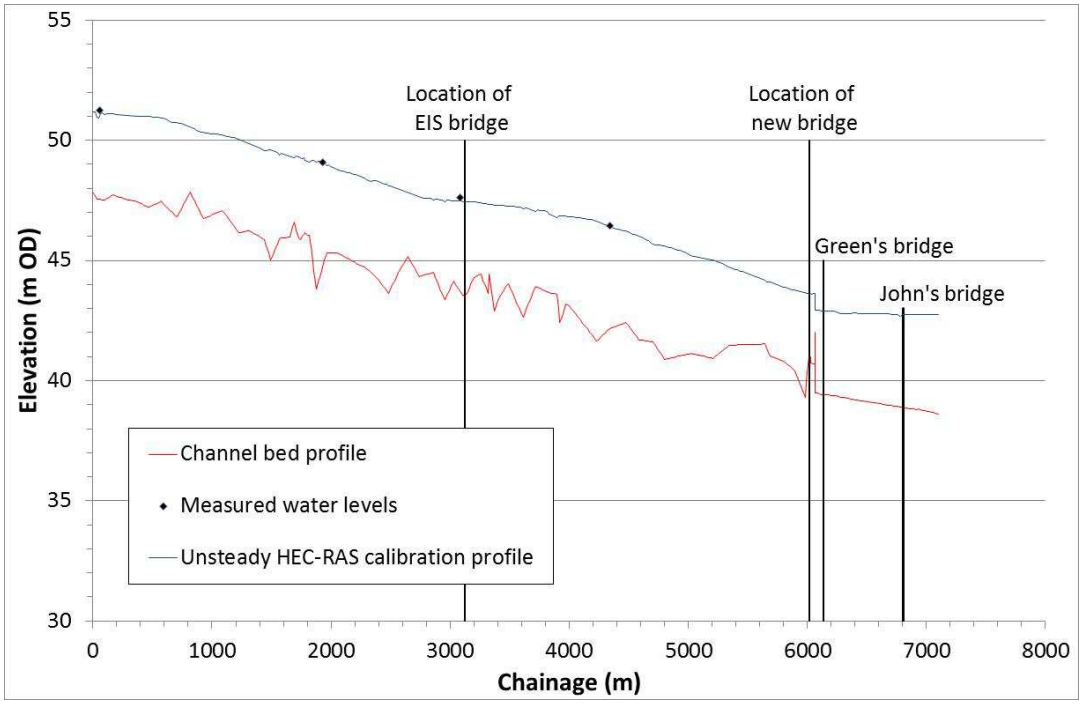


Chart 8.04 Unsteady flow HEC-RAS calibration profile for flood on the 29th October 2010

8.4 Potential Impacts of the Proposed Bridge

Section 8.1 sets out the key questions being addressed in this EIS. These are presented individually in the sections that follow.

8.4.1 Predicted Flood Water Levels for the 100-Year Design Flood

Predicted flood water levels for the river channel in its existing condition and those for the channel with the proposed river crossing were determined by executing the steady-flow HEC-RAS model with the inputs in Table 8.2. As described previously, these inputs were extracted from OPW/ Mott McDonald EPO reports and were based on findings from the physical model of the Kilkenny Flood Defence Scheme developed by HR Wallingford Ltd**.**

Table 8.2 100-year flow input parameters for the HEC-RAS steady flow model

River Nore Discharge (m^3/s)	Breagagh River Discharge (m^3/s)	Downstream Water Surface Elevation Boundary Condition (m OD Malin Head)
440	35	44.17

Two specific geometries were considered. That for the existing condition included the current channel geometry and floodplain topography together with Green's Bridge, the three arches of John's Bridge and the new bridge, approved by Kilkenny County Council, that will be located approximately 120 m downstream of Green's Bridge. This formed the basis of the second geometry that also included the proposed bridge that is the subject of this EIS.

Tabulated water surface profiles for an 1880 m river reach upstream of the proposed bridge and for approximately 300 m downstream of the proposed bridge location (from cross-section 13 to cross-section 44) are summarised in Table 8.3. The 1880 m upstream reach represents the distance for which the proposed bridge options produce increases in water surface profiles, although small, above the existing condition profile. Table 8.3 indicates that the maximum impact on upstream water levels (the proposed bridge is located between cross-sections X and Y) is approximately 0.02 m.

Table 8.3 100-year water surface elevations for the existing channel and for the channel with the proposed bridge

Cross-Section	Chainage from upstream extent of model (m)	Bed Elevation (m)	Water Surface Elevation (m OD)		Difference (m)
			Existing Condition	With Proposed Bridge	
13	1227.0	46.16	51.35	51.35	0
14	1312.0	46.23	51.16	51.16	0
15	1440.0	45.88	50.96	50.97	0.01
16	1495.5	45.01	50.92	50.93	0.01
17	1566.5	45.90	50.58	50.58	0
18	1656.5	45.98	50.62	50.62	0
19	1676.5	46.41	50.55	50.56	0.01
20	1690.0	46.60	50.60	50.61	0.01
21	1726.0	45.95	50.56	50.56	0
22	1743.0	45.87	50.52	50.52	0
23	1762.0	46.01	50.47	50.47	0
24	1782.5	46.16	50.35	50.35	0
25	1802.0	46.03	50.32	50.32	0
26	1820.5	46.05	50.30	50.30	0
27	1873.5	43.82	50.25	50.26	0.01
28	1965.5	45.32	50.09	50.09	0
29	2066.0	45.29	49.97	49.97	0
30	2192.0	44.94	49.84	49.85	0.01
31	2301.0	44.67	49.90	49.91	0.01
32	2383.0	44.28	49.89	49.89	0
33	2484.5	43.64	49.86	49.87	0.01
34	2565.0	44.49	49.22	49.24	0.02
35	2645.5	45.18	49.39	49.41	0.02
36	2740.5	44.33	49.19	49.21	0.02
37	2858.0	44.50	49.38	49.40	0.02
38	2954.0	43.37	49.34	49.35	0.01
39	3031.0	44.13	49.36	49.37	0.01
W	3097.5	43.62	49.35	49.37	0.02
X	3107.5	43.54	49.35	49.37	0.02
Y	3136.5	43.59	49.35	49.35	0
Z	3146.5	43.71	49.35	49.35	0
41	3199.0	44.30	49.34	49.34	0
42	3259.0	44.42	49.33	49.33	0
A	3279.0	44.15	49.33	49.33	0
B	3288.0	44.03	49.33	49.33	0
C	3317.0	43.63	49.32	49.32	0
D	3327.0	44.42	49.32	49.32	0
43	3370.0	42.91	49.31	49.31	0
44	3420.0	43.54	49.31	49.31	0

8.4.2 Predicted Flood Water Levels for the 100-Year Design Flood with Climate Change

The impact of a 20% climate change factor on flood water levels was assessed using the steady flow model with the inputs in Table 8.4.

Predicted flood water levels for the river channel in its existing condition and those for the channel with the proposed river crossing were determined by executing the steady-flow HEC-RAS model with these inputs. As described previously, these inputs were extracted from OPW/ Mott McDonald EPO reports and were based on findings from the physical model of the Kilkenny Flood Defence Scheme developed by HR Wallingford Ltd.

Table 8.4 100-year flow (with climate change factor) input parameters for the HEC-RAS steady flow model

River Nore Discharge (m^3/s)	Breagagh River Discharge (m^3/s)	Downstream Water Surface Elevation Boundary Condition (m OD Malin Head)
530	40	44.22

Predicted water surface elevations from Cross-section 13 to Cross-section 44 for the climate scenario for both the existing condition and for the river channel with the proposed bridge are summarised in Table 8.5. Data indicates that the maximum impact on upstream water levels (the proposed bridge is located between cross-sections X and Y) is approximately 0.03 m.

Table 8.5 100-year (with climate change factor) water surface elevations for the existing channel and for the channel with the proposed bridge

Cross-Section	Chainage from upstream extent of model (m)	Bed Elevation (m)	Water Surface Elevation (m OD)		Difference (m)
			Existing Condition	With Proposed Bridge	
13	1227.0	46.16	51.75	51.76	0.01
14	1312.0	46.23	51.56	51.56	0
15	1440.0	45.88	51.39	51.40	0.01
16	1495.5	45.01	51.34	51.35	0.01
17	1566.5	45.90	50.98	50.99	0.01
18	1656.5	45.98	51.04	51.05	0.01
19	1676.5	46.41	50.99	51.00	0.01
20	1690.0	46.60	51.04	51.04	0
21	1726.0	45.95	50.98	50.99	0.01
22	1743.0	45.87	50.95	50.96	0.01
23	1762.0	46.01	50.90	50.91	0.01
24	1782.5	46.16	50.78	50.79	0.01
25	1802.0	46.03	50.76	50.77	0.01
26	1820.5	46.05	50.75	50.76	0.01
27	1873.5	43.82	50.70	50.71	0.01
28	1965.5	45.32	50.55	50.57	0.02
29	2066.0	45.29	50.47	50.49	0.02
30	2192.0	44.94	50.36	50.37	0.01
31	2301.0	44.67	50.42	50.44	0.02
32	2383.0	44.28	50.41	50.43	0.02
33	2484.5	43.64	50.40	50.41	0.01
34	2565.0	44.49	49.83	49.86	0.03
35	2645.5	45.18	49.97	50.00	0.03
36	2740.5	44.33	49.78	49.81	0.03
37	2858.0	44.50	49.97	49.99	0.02
38	2954.0	43.37	49.93	49.96	0.03
39	3031.0	44.13	49.94	49.97	0.03
W	3097.5	43.62	49.94	49.97	0.03
X	3107.5	43.54	49.94	49.97	0.03
Y	3136.5	43.59	49.94	49.94	0
Z	3146.5	43.71	49.94	49.94	0
41	3199.0	44.30	49.93	49.93	0
42	3259.0	44.42	49.93	49.93	0
A	3279.0	44.15	49.92	49.92	0
B	3288.0	44.03	49.92	49.92	0
C	3317.0	43.63	49.92	49.92	0
D	3327.0	44.42	49.92	49.92	0
43	3370.0	42.91	49.91	49.91	0
44	3420.0	43.54	49.90	49.90	0

8.4.3 Assessment of the Loss of Floodplain Storage from the Proposed Structure

Although the proposed structure is designed to maintain maximum hydraulic connectivity between the north and south floodplains on each side of the proposed structure, the impact of any loss in floodplain storage from the embankment of the bridge was assessed. This was done using the unsteady HEC-RAS model executed using the 100-year flood hydrograph in Chart 8.02 at the upstream boundary and the John's Bridge stage-discharge rating at the downstream boundary. Any discernible loss in floodplain storage would be evident in a comparison of stage hydrographs both upstream (Cross-section X) and downstream (Cross-section Y) of the proposed structure for the existing condition and for the river channel with the bridge.

Chart 8.05 shows the simulated hydrographs at Cross-section X for the channel in its existing condition and with the proposed bridge. Corresponding hydrographs are shown in Chart 8.06 for Cross-section Y downstream of the proposed bridge.

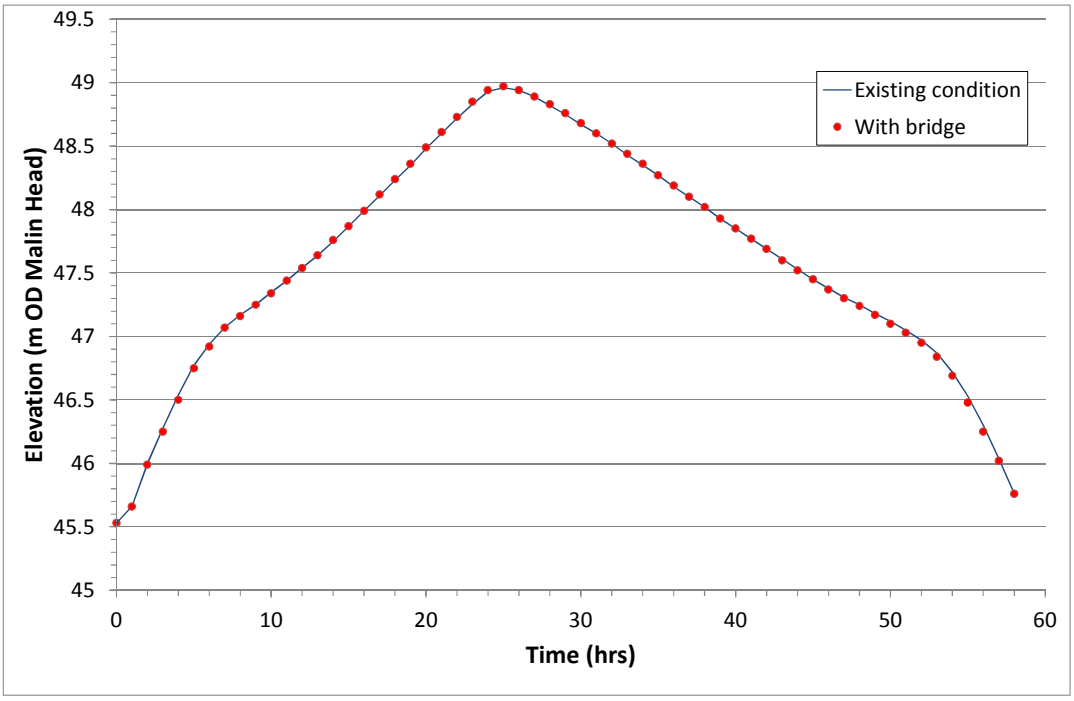


Chart 8.05 100-year stage hydrographs at Cross-section X (upstream location of proposed bridge) for the existing condition and for the river channel with the proposed bridge

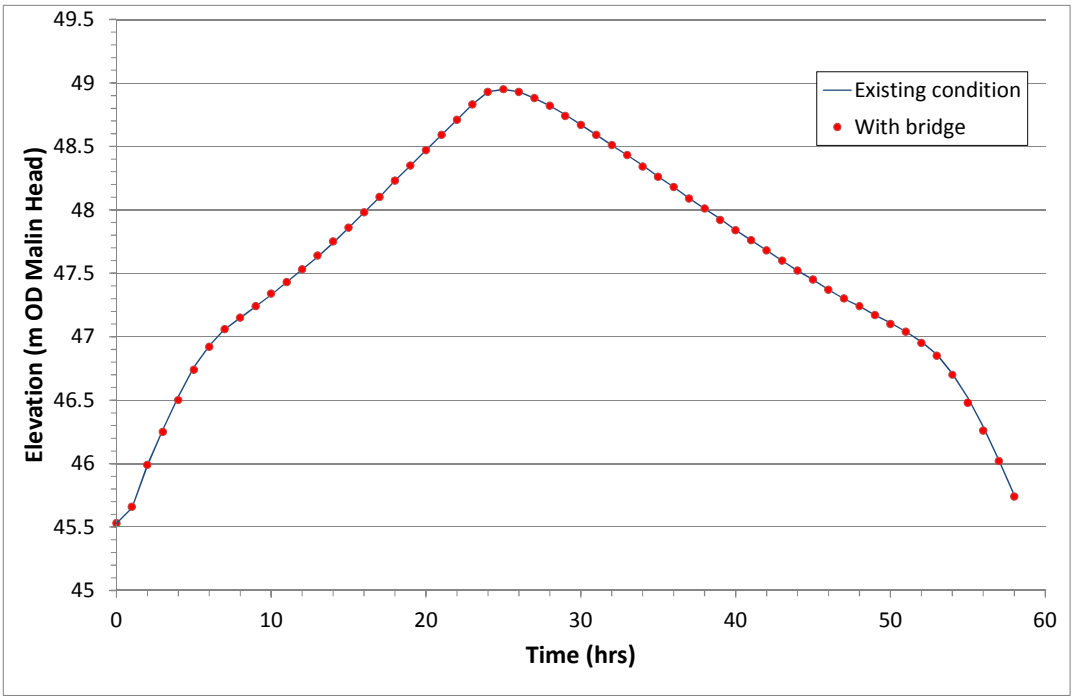


Chart 8.06 100-year stage hydrographs at Cross-section Y (downstream location of proposed bridge) for the existing condition and for the river channel with the proposed bridge

The data indicates that differences in water level at locations upstream and downstream of the proposed bridge for the pre and post-bridge scenarios are very insignificant, indicating that the loss of floodplain storage from the structure is having only minimal effects on the flood water levels in the entry and exit reaches to and from the bridge.

8.4.4 Description of Proposed Works

The proposed scheme is shown in Figures 4.01, 4.02, and 4.03. The proposed bridge is designed as a three-span structure with a centre span of 45m and edge spans of 22.5m each, supported by abutments at each end.

The River Nore floodplain will be crossed by 21No. culverts/underpasses which will allow the flood water to dissipate following a flood event at the same rate and in the same manner as that which occurs at present.

8.4.5 Potential Impacts during Operational Phase

The proposed Scheme is predicted to provide a maximum water surface elevation of 0.03m above existing, immediately upstream of the bridge.

8.4.6 Potential Impacts during Construction Phase

Water Quality

Pollutants and chemicals used during the bridge construction could have toxic impacts on the flora and fauna in the adjacent waters. The likely sources of chemical contamination would be from site machinery and vehicles. Pollution could occur in a number of ways, neglected spillages, the improper storage, handling and transfer of oil and chemicals and refuelling of vehicles. Accidental leakage or discharge of chemicals and pollutants could cause changes in the pH of the water and could have a direct toxic impact on the flora and fauna on the watercourse at-site and further downstream. If waters become polluted, species more tolerant to pollution can extend their distribution, thus altering the species composition of the watercourse. Polluted waters are generally lower in biodiversity. Pollution of the adjacent freshwaters from on-site sewage could also have a toxic impact on flora and fauna. An increase in nutrients, organic mayyer and various toxins at the point of pollution would be likely to occur, which could result in a loss of species, particularly those sensitive to pollutants, from that area.

Erosion and Sedimentation/ Siltation

Construction works associated with the proposed bridge have significant potential to cause the release of sediments into the adjacent watercourse, particularly due to the removal and storage of topsoil. The release of suspended solids could result in direct and indirect fishery impacts. Direct impacts include the clogging of fish gills with sediment, while indirect impacts include the alteration of habitat, reduced visibility for feeding and impacts on the food supply, especially on aquatic invertebrates. Effects on aquatic macroinvertebrates would include clogging of habitats, such as riffles and smothering of organism with settling sediment, which would lead to alteration on the community structure (species and relative abundance).

8.5 Mitigation Measures

The engineering works presented in detail (see Section 4) will ensure that the design flood can be accommodated in the channel and floodplains with only very minor changes from the existing situation. Therefore, no further mitigation measures are necessary in the context of the predicted changes to the river's flow regime.

However, a number of mitigation measures should be implemented to reduce or remove any potential negative impacts on the River Nore as a result of the proposed scheme.

8.5.1 Construction Phase Mitigation Measures

Water Quality

All fuels or chemicals kept on the construction site should be stored in bunded containers. All machinery should be well-maintained and refuelling carried out within bunded enclosures. Oil interceptors should also be installed. Accidental spillages should be contained and cleaned up immediately. Remediation measures should be carried out in the unlikely event of pollution of the

adjacent watercourse in accordance with best practice. During the construction phase, contained chemical toilets should be used and all sewage removed from the site to an authorised treatment works. In this way, no sewage would be discharged to watercourses. Best practice should be followed at all times.

Erosion and Sedimentation/ Siltation

Measures will be implemented to reduce the release of sediment into the watercourse. Any storage of sand/ gravel/ soil should be located away from the watercourse. Surface water run-off should be collected in specially designed settlement lagoons or silt/ gravel traps to remove suspended solids before being discharges to the watercourse. Best practice should be followed at all times. Little can be done to prevent the release of suspended solids into the river for the works that will immediately adjacent to the main stream, however works should be timed according to recommendations from Inland Fisheries Ireland.

8.5.2 Operational Phase Mitigation Measures

There are no Operational Phase mitigation measures required.

8.6 Residual Impacts

The residual impacts will be minimized with a maximum of 30mm increase in existing water levels (in a 100-year storm) immediately upstream of the bridge. Hence there will be negligible increase of flood risks.

8.7 Interaction and Inter-relationships with other Environmental Effects

Hydrology will interact and/or interrelate with:

- Ecology: There are clear interactions between ecological receptors and water resource features. This issue is discussed in more detail in Chapter 7 – Flora and Fauna.

8.8 Monitoring

A continuous programme of channel maintenance is required to ensure that the channel discharge capacity does not decrease with time. Over time, natural channels have a tendency to become overgrown with vegetation, both marginal and mid-stream. The increase in hydraulic resistance that occurs with this vegetation reduces flow velocities and results in increased water levels for all flows. Flooding or influences on flood processes can also be exacerbated by blockages in a watercourse, particularly where heavy debris becomes snagged at hydraulic structures such as bridges or culverts, restricting flood flows.

Regular watercourse maintenance is therefore essential for reducing both overall and local flood risk in a channel. This has been recognised in the report of the Flood Policy Review Group (2004) where maintenance is accepted as a flood relief measure, particularly in high risk areas.

On a more holistic basis, it is also recommended that an integrated catchment management strategy to cover issues relating to water quality and quantity, floodplain management, fisheries and habitat protection, be implemented for the River Nore. The adoption of such a strategy is in accordance with the Water Framework Directive (WFD) which embraces all aspects of river systems with the objective of establishing “good” water quality status by 2015.

8.9 Reinstatement

There is no reinstatement required.

8.10 Difficulties Encountered in Compiling this Information

None.

9.0 SOILS, GEOLOGY AND HYDROGEOLOGY

9.1 Introduction

This section of the Environmental Impact Statement (EIS) was undertaken by AWN Consulting Limited (AWN), on behalf of Kilkenny County Council to evaluate and assess the potential impacts of the proposed Kilkenny Northern Ring Road Extension (proposed road development) on the surrounding soils, geology and hydrogeology (groundwater) environment.

The potential impacts and mitigation measures for soils, geology and groundwater during both the construction and operational phases of the proposed ring road development are set out in the following sections.

9.2 Assessment Methodology

The assessment of the potential impact of the proposed road development on soils, geology and hydrogeology was carried out according to the methodology specified in the guidance documents listed below, the references of which are detailed at the end of this chapter.

- National Roads Authority (NRA) *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes* [1]
- National Roads Authority (NRA) *Environmental Impact Assessment of National Road Schemes – A Practical Guide* (2008) [2]
- National Roads Authority (NRA) *Guidelines for the Management of Waste from Road Construction Projects* (2008) [3]
- Environmental Protection Agency (EPA) *Guidelines on the Information to be Contained in Environmental Impact Statements* (2002) [4]
- Environmental Protection Agency (EPA) Advice Notes on Current Practice (in the Preparation of EIS) (2003) [5]

The main aim of the soils, geology and hydrogeology assessment is to identify any potential impacts arising from a change in the geological and hydrogeological regime, recommend appropriate mitigation measures and highlight any residual impacts.

The collection of baseline data to establish and assess the receiving environment was undertaken by focusing upon a review of the following sources:

- The Geological Survey of Ireland (GSI) well card and groundwater records, bedrock geology and aquifer mapping (classification and type - gravel and bedrock), Quaternary (subsoils) map; minerals and quarry database, karst feature database, groundwater wells database;[6]
- Geology of Carlow-Wexford, Geological Description to accompany Sheet 19, GSI;

- The Geological Heritage of Kilkenny report, GSI, 2007;
- Geotechnical Site Investigation Borehole Logs, IGSL, 2009;
- Teagasc - Soil and Subsoil database;
- GSI Groundwater Body Descriptions;[7]
- Water Framework Directive Monitoring Programme, EPA 2006 [8]
- River Basin District Characterisation Reports [9]
- Geology in Environmental Impact Statements – A Guide [10]
- Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors, (CIRIA 532, 2001); [11]
- Office of Public Works (OPW);
- Local Authority -information on public water supplies, quarries and licensed sites;
- Environmental Protection Agency (EPA) - identification of any licensed sites, contaminated sites and legacy landfills, and;
- National Parks and Wildlife Services (NPWS) - information on protected habitats (NHAs, SACs, SPAs).

Specific consultation correspondence was carried out with the following relevant bodies:

- Geological Survey of Ireland (GSI)
- Department of Environment, Heritage & Local Government (DoEHLG)
- Office of Public Works (OPW)
- Environmental Protection Agency (EPA)
- National Roads Authority (NRA)
- An Taisce
- The Heritage Council
- Inland Fisheries Ireland (IFI)

The responses from relevant stakeholders are included in Appendix C.

The quality, magnitude and duration of potential impacts is defined in accordance with the assessment criteria provided in the EPA publication 'Guidelines on the Information to be contained in Environmental Impact Statements' (2002)[1], outlined in Tables 9.1, 9.2 and 9.3.

Table 9.1 – Impact Assessment Criteria (Quality)

Quality of Impacts	Description
Positive Impact	A change which improves the quality of the environment (for example, by increasing species diversity; or the improving reproductive capacity of an ecosystem, or removing nuisances or improving amenities).
Neutral Impact	A change which does not affect the quality of the environment.
Negative Impact	A change which reduces the quality of the environment (for example, lessening species diversity or diminishing the reproductive capacity of an ecosystem; or damaging health or property or by causing nuisance).

Table 9.2 – Impact Assessment Criteria (Magnitude)

Magnitude of Impact	Description
Imperceptible	An impact capable of measurement but without noticeable consequences
Slight	An impact that alters the character of the environment without affecting its sensitivities
Moderate	An impact that alters the character of the environment in a manner that is consistent with existing or emerging trends
Significant	An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
Profound	An impact which obliterates all previous sensitive characteristics

Table 9.3 – Impact Assessment Criteria (Duration)

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

The principal attributes and impacts to be assessed include the following:

Soils & Geology

- Geological heritage sites in the vicinity of the proposed route;
- Landfills, other backfilled quarries or former industrial sites in the vicinity of the proposed route and the potential risk of encountering contaminated ground;
- Quality, drainage characteristics and range of agricultural uses of soil in the vicinity of the proposed route;

- Other pits, quarries or mines in the vicinity, the potential implications (if any) for existing activities and extractable reserves;
- Extent of subsoil cover in the area;
- The presence of any karst features, and
- Possibility of geo-hazards (if any) resulting from landslide activities in the region.

Hydrogeology

- High yielding water supply springs/ wells in the vicinity of the proposed route to within a 1km radius and the potential for increased risk presented by the proposed road development;
- Classification (regionally important, locally important) and extent of aquifers underlying the study area and increased risks presented to the aquifers by activities related to the proposed road development associated with aspects such as for example removal of subsoil cover, removal of aquifer (in whole or part), drawdown in water levels, alteration in established flow regimes, change in groundwater quality;
- Natural hydrogeological features in the area and potential for increased risk presented by the activities associated with the proposed road development; and
- Groundwater-fed ecosystems and the increased risk presented by the activities related to the construction and operational phase of the proposed route, both spatially and temporally.

9.2.1 Water Framework Directive

The Water Framework Directive (WFD) Directive 2000/60/EC, was adopted in 2000 as a single piece of legislation covering rivers, lakes, groundwater and transitional (estuarine) and coastal waters. In addition to protecting said waters, its objectives include the attainment of 'Good status' in waterbodies that are of lesser status at present and retaining 'good status' or better where such status exists at present. 'Good status' is to be achieved in all waters by 2015, as well as maintaining 'high status' where the status already exists. The EPA co-ordinates the activities of the River Basin Districts, local authorities and state agencies in implementing the directive, and operates a groundwater quality monitoring programme undertaking surveys and studies across the Republic of Ireland.

Groundwater quality is classified following a WFD Waterbody Risk Score consisting of the following categories:

- No score
- 1a – At risk of not achieving good status
- 1b – Possibly at risk of not achieving good status
- 2a – Expected to achieve good status
- 2b – Strongly expected to achieve good status

Groundwater quality is classified as generally being of 'Good' or 'Poor' status.

9.3 Characteristics of the Proposed Development

The proposed road development is the 'Kilkenny Northern Ring Road Extension – (Freshford Road to Castlecomer Road' project, which is the new ring road extension for Kilkenny City.

The preferred route links the existing roundabout at the intersection of the N77 ring road extension with the N77 Castlecomer National Secondary Route to a new roundabout approximately 1.5 kilometres to the west on the R693 Kilkenny to Freshford Regional Route. The alignment will involve crossing the River Nore and also a local county road referred to as the 'Bleach Road' which runs in a north-south direction to the east of the River Nore.

9.4 Receiving Environment

9.4.1 Bedrock Geology

Inspection of the available Geological Survey Ireland (GSI) mapping records show that the bedrock geology underlying the site mostly consists of the Killeshin Siltstone Formation. The geological formations underlying the proposed route from west to east include the following:

- Killeshin Siltstone Formation (described as muddy siltstone & silty mudstone); this is the predominant formation type underlying the preferred route and stretches approximately from Chainage Ch:1+170 to Ch:0. According to the GSI geological description, the Killeshin Siltstone Formation consists of grey argillaceous siltstones or silty mudstones, with lesser amounts of sandstone and shale. The siltstones are poorly bedded with an irregular conchoidal fracture;
- Luggacurren Shale Formation (described as mudstone & shale with chert & limestone); this geological formation generally lies along Chainage Ch:1+170 to Ch:1+430. According to the GSI geological description, the Luggacurren Shale Formation is characterised by black to grey shales and mudstones, with thin argillaceous cherts and limestones found in the lower ; and
- Clogrenan Formation.Cherty (described as muddy, calcarenitic limestone): this bedrock geology is present to the east of the proposed route at the link to the N77.

The bedrock geology map is included as Figure 9.01.

There are no geological faults are indicated on the GSI bedrock geology maps beneath the proposed road development but a geological fault (synclinal axis) is indicated approximately 3km to the north-east of Chainage Ch:1+430. Geological faults in the wider regional area would be expected to influence the local hydrogeological regime to some extent because they would facilitate groundwater flow. It should be noted, however, that the location of geological faults on bedrock maps by the GSI is indicative only.

The GSI Karst feature database was consulted for assessment of baseline karst related data. Available records show an absence of karst features along the alignment of the preferred route. The

nearest features comprise springs located at a distance of greater than 1km from the initial and final chainage points of the proposed route.

Site Specific

The results of preliminary site investigations for the proposed road development indicate bedrock depths within two rotary boreholes along the proposed route for RC1 at 11.20m below ground level (bgl) (underlying clay and gravels) and for RC2 at 13.40m bgl (underlying clay, silt and gravels). The bedrock geology was recorded as strong to locally moderately strong, thin to medium bedded, dark grey, fine grained limestone, fresh to slightly weathered in both boreholes. Apertures were recorded as tight to open with local slightly iron oxide staining, with dips ranging from sub-vertical to 40° with variable fractures throughout.

No water strikes were noted in either borehole to termination depths of 16.2mbgl and 19.0mbgl, for RC1 and RC2, respectively.

9.4.2 Superficial Deposits

Quaternary Period

According to the GSI Geological Description report, the Quaternary geological period extends from about 1.6 million years ago to the present day. All the surface deposits of the route were deposited during the Quaternary period.

As the ice travelled over the ground, it eroded the underlying bedrock, which resulted in the formation of sediment beneath and within the ice sheet. The particle size distribution of the sediment varied greatly and ranged from clay particles to large boulders. This material has been labelled glacial till or boulder clay and is the most widespread soil type in Ireland. If conditions were suitable, sediment was also deposited as distinct bands of sand, gravel, silt and clay. Glacial till can range in thickness from less than 1m thick to tens of metres in depth.

The Midland ice carried with it limestone debris and limestone is common in tills in the area and a high lime content is often found in the soils.

Soils & Subsoils Mapping

The Teagasc Soil Map of Ireland shows the drift geology covering the site to be derived from limestone glacial till which is to be expected, given the nature of the underlying bedrock. According to the GSI/Teagasc Subsoil mapping, the superficial deposits in the area include the presence of large granular deposits underlying the proposed road development, consisting of Carboniferous limestone sands and gravels (GLs) and which may represent glacial meltwater gravels along the profile of the River Nore. Where the route crosses the River Nore, the superficial deposits consist of undifferentiated gravelly Alluvium (A).

To the west of the proposed route, the superficial deposits generally comprise glacial till derived from Namurian Rocks (TNSSs).

The EPA soils mapping indicates that the soils comprise primarily of shallow well drained soils derived from basic parent materials (BminSW).

The subsoil and soil geology maps are included as Figures 9.02 and 9.03, respectively.

Site Specific

Preliminary site investigations involving six cable percussive boreholes for the proposed road development have found the superficial deposits to consist of both cohesive and granular material. Generally, the downward succession of the boreholes drilled along the proposed route included sandy gravelly clay with cobbles/gravel with cobbles, overlying silt/clay bands which in turn was found to occasionally overly deeper gravels with cobbles. Depths of overburden observed from the preliminary site investigation works ranged from between 7m to 11.20m, however subsequent rotary drilling along the proposed route proved overburden thicknesses to a depth of 19.0m adjacent to the River Nore. Groundwater ingress was encountered during cable percussive drilling with occasional 'moderate' to 'rapid' groundwater ingress noted in gravels at depths of <4mbgl. The waterstrikes were noted in boreholes drilled to the east of the River Nore.

9.4.3 Geological Heritage

The Geological Survey of Ireland (GSI) Irish Geological Heritage (IGH) Programme was contacted to determine if any geological heritage issues were present in relation to the quarry site.

The GSI response, included in Appendix C, stated that there are no geological sites of interest, either recommended for CGS or NHA designation in the vicinity of the proposed Kilkenny Northern Ring Road extension. The GSI's Geological Heritage of County Kilkenny report was consulted to confirm this.

For information, the GSI identified the closest sites of interest within a 5km radius lie at about 4.5km from the proposed development and stated that the sites are unlikely to be affected by the works. These sites are:

- Three castle quarry to the north west;
- Ballyfoyle channels to the north east;
- Archersgrove quarry to the south east.

9.4.4 Economic Geology

The GSI mineral database was consulted to determine whether there were any mineral sites close to the study area. Generally, these are absent with active localities located at distances of greater than

1km from the site, with the nearest site located at approx. 1.6km to the south of the proposed route. This particular mineral site is labelled as an inactive gravel pit.

The Geological Survey of Ireland Directory of Active Quarries, Pits and Mines (2001) was also consulted to identify any active workings in the area. The directory does not identify any workings in the immediate vicinity of the proposed route. The nearest quarry (active 2001) indicated on the GSI database is the Holdensrath Quarry described as an Active quarry producing limestone monumental and limestone. The quarry is located in the townland of Holdensrath, situated approximately 2km to the south-west of the proposed road development. Three other quarries were identified by the GSI, and are listed in Section 9.4.3 above.

9.4.5 Geo-Hazards

According to the GSI web database, there are presently no records of geo-hazards such as landslides, within a radius of 10km of the proposed route.

9.4.6 Surface Water

The River Nore is the surface water feature in the area of the proposed road development with the preferred route crossing this watercourse at chainage Ch: 400 to 450. Available drawings for the proposed route indicate the presence of local land drains crossing the central alignment at chainage Ch: 1+040 and Ch: 1+250 on agricultural lands to the east of the River Nore. Surface Water is discussed in detail in Section 4.5 of this EIS.

9.4.7 Aquifer Classification

Groundwater can be defined as water that is stored in, or moves through, pores and cracks in sub-soils. The potential of rock to store and transport water is governed by permeability of which there are two types, inter-granular and fissure permeability. Inter-granular permeability is found in sediments, sands, gravels and clays, and fissure permeability which is found in bedrock, where water moves through (and is stored in) cracks, fissures, fracture planes and solution openings.

Aquifers are generally classified as rocks or other matrices that contain sufficient void spaces and which are permeable enough to allow water to flow through them in significant quantities.

The GSI online records and national draft bedrock aquifer map shows the aquifer underlying the proposed route is classified as Rg - Regionally Important extensive sand/gravel aquifer, which is part of the Nore Gravels Group. The gravel aquifer classification is presented in Figure 9.04a. Regionally important aquifers would usually be sufficiently productive to be able to yield enough water to boreholes or springs to supply major regional water schemes.

The GSI National Draft Bedrock Aquifer Map indicates the bedrock aquifer underlying the majority of the proposed road development as PI which is described as a Poor Aquifer – i.e. bedrock which is generally unproductive except for local zones, see Figure 9.04b. To the east of the route the bedrock aquifer is classified as PU (poor aquifer). The eastern end of the proposed route terminates at the boundary of the regionally important aquifer. A poor aquifer would be normally capable of yielding only sufficient water from wells or springs to supply single houses, small farms or small group schemes. Expected yields would generally be less than 40m^3/d, although occasionally yields between 40m^3/d and 100 m^3/d may be encountered in fracture zones.

9.4.8 Groundwater Flow

Regional groundwater flow direction within the gravels is expected to be in the direction of the River Nore, i.e. with regional flow orientations of 'west to east' and 'east to west'. This aquifer may also make a significant base flow contribution to the River Nore.

In bedrock areas, the groundwater flow system is expected to flow through a diffuse network of conduits. Groundwater flow paths in the bedrock are expected to be short because the bedrock is not a regionally important aquifer.

9.4.9 Groundwater Quality & Water Framework Directive

The proposed road development is located in the South Eastern River Basin District. Groundwater quality in the region of the proposed route is classified as '*Good status'* following the WFD Groundwater Status results.

The preferred route is underlain by the Dunmore Groundwater Body (GWB) which is reported by the GSI as having a gravel flow regime. A report is not currently available on this groundwater body.

9.4.10 Aquifer Vulnerability

Aquifer vulnerability is a term used to represent the intrinsic geological and hydrological characteristics that determine the ease with which groundwater may be contaminated generally by human activities. The main feature that protects groundwater from contamination, and therefore the most important feature in protection of groundwater, is the subsoil (which can consist solely/ or of mixtures of peat, sand, gravel, glacial till, clays or silts).

This indicates the presence of between 3 - 10m of moderately permeable subsoils or 3 - 5m of low permeability subsoils overlying the bedrock aquifer, as shown in Table 9.4.

Reference to the GSI Interim Vulnerability Groundwater Map indicates that the vulnerability of the bedrock aquifer beneath the entire extent of the proposed road development has been classed as (H) High, as shown on Figure 9.05.

The section of the proposed route to the west of the River Nore at the link to the R693 lies approximately 200m south of an area where the aquifer vulnerability classification changes to (E, X) Extreme which denotes an area of possible rock at/ near surface or karst.

Table 9.4 – Vulnerability Mapping Guidelines

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High permeability (sand/gravel)	Moderate permeability (e.g. Sandy subsoil)	Low permeability (e.g. Clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(<30 m radius)
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 - 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Notes: (1) N/A = not applicable.
(2) Precise permeability values cannot be given at present.
(3) Release point of contaminants is assumed to be 1-2 m below ground surface.

Groundwater Source Protection Areas

The GSI groundwater database indicates that there are no GSI or EPA groundwater source protection areas in the vicinity of the proposed Kilkenny Northern Ring Road development.

9.4.11 Groundwater Wells

The GSI Well Card Data search found a number of groundwater wells in the vicinity of the preferred route for the ring road extension. The location and reference number of the groundwater wells is shown on Figure 9.06. Further details of the groundwater wells listed in this figure are summarised in Appendix K.

The closest groundwater well to the site is located <100m to the south of the proposed route eastern section and is identified as Number 1 on Figure 9.06. This location is a borehole well, used for both agricultural and domestic use. The well was drilled in 1968 to a depth of 26.5mbgl and is classed as 'Poor' in terms of yield (approx. 87m^3/d).

The next closest groundwater well is borehole Number 3, which is located approximately 300m north of the proposed route in the vicinity of the same section of the alignment as borehole Number 1. This is a dug well to a depth of 4mbgl only with depth to bedrock unknown. No detail on this shallow well is available other than providing water for both agricultural and domestic use.

9.4.12 Groundwater Permeability

Available data on the permeability characteristics of the gravel aquifer is limited. Specific reference to groundwater ingress encountered during cable percussive drilling as part of the preliminary site investigation for the proposed route indicated occasional 'moderate' to 'rapid' groundwater ingress as a result of waterstrikes predominantly in gravels at depths of <4mbgl. The waterstrikes were noted in boreholes drilled to the east of the River Nore.

9.4.13 Groundwater & Areas of Conservation

The proposed road development crosses three areas of conservation, namely the following:

1. Dunmore Complex (Site Code: 001859) a proposed Natural Heritage Area (pNHA);
2. River Barrow and River Nore (Site Code: 002162) Special Area of Conservation (SAC); and
3. River Nore (Site Code: 004233) Special Protected Area (SPA).

Chapter 7 discusses the impact on these sites in more detail.

The consultation response from the Fisheries (see Appendix C) notes that the main channel of the River Nore is a formally designated salmonid water under S.I. 293 of 1988.

9.4.14 Landfills and Licensed Sites

The EPA has a database of waste and Integrated Pollution Prevention Control (IPPC) licenced activities in Ireland. According to the EPA (2013) there are no licensed IPPC facilities or licensed waste sites in the vicinity of the proposed road development.

9.5 Predicted Impacts

The potential impacts of the construction and operational phases of the proposed development on the soil, geological and hydrogeological environment are outlined in the following sections.

9.5.1 Construction Phase

Accidental Spills and Leaks

During construction of the road development, there is a risk of accidental pollution incidences from the following sources:

- Spillage or leakage of oils and fuels stored on site.
- Spillage or leakage of oils and fuels from construction machinery or site vehicles.
- Spillage of oil or fuel from refuelling machinery on site.

Accidental spillages may result in contamination of soils and groundwater underlying the site, should contaminants migrate through the subsoils and impact underlying groundwater in gravel and bedrock aquifers.

The generation of suspended solids due to soil stripping and subsequent soil erosion could also potentially result in direct percolation to receiving waters causing pollution.

Surface Water Runoff

Surface water runoff during the construction phase may contain increased silt levels or become polluted from construction activities. Runoff containing large amounts of silt could impact on the groundwater in the gravel and bedrock aquifer underlying the site. Silt water can arise from exposed ground and soil stockpiles (prior to reinstatement).

Soil Removal and Compaction

All topsoil and unsuitable subsoils will be stripped and removed from the proposed route and temporary access routes prior to construction. This loss of natural soil is an essential part of the development.

There is potential for the erosion of soils during construction. The removal of established vegetative cover could lead to the loss of large quantities of soil particles to the gravel and bedrock aquifer, which can cause significant pollution of groundwater through the generation of suspended solids. Similarly excavation in cuttings could result in the migration of sediment to groundwater.

Raising of the ground level will be required along much of the route. The ground level will be raised by up to 6m to the east of the route (around CH1+260). Geological issues to be considered with regards to the raising of ground level include settlement of the existing ground profile, slope stability of the constructed embankments and determining a source for the material required.

Limited areas of cut are required during construction. The areas of cut are generally to the west of the River Nore and are up to 2.4m in depth. Borehole logs from the area (BH1) indicate the cuttings will be in sandy and gravelly clay. Bedrock will not be encountered during cutting.

The bridge will be located from CH 390 and will consist of an arched culvert with concrete piles to competent ground. The impact of the bridge on the geological environment will largely depend on the founding level of the proposed structure and a program of dewatering may be employed during construction.

Dewatering

Groundwater may be encountered in shallow sand and gravel deposits during cutting. Should dewatering be required during the cuts, dewatering techniques to facilitate construction activities will result in temporary drawdown of groundwater potentially impacting groundwater in the gravel and bedrock in the vicinity during construction. There is potential for migration of fines during the lowering of the groundwater table when encountered during and prior to cutting activities resulting in an impact

on groundwater quality. However, as limited area of cut only are required and borehole logs from the area indicate that the cuttings are not in saturated strata, it is considered that any dewatering required will be localised and small scale.

A program of dewatering may be employed during the construction of the bridge. Dewatering for the bridge structure may be more comprehensive, depending on the founding level of the proposed structure. It is noted that there are no groundwater supply boreholes in the vicinity of the bridge structure, however the structure is located within the River Nore SPN.

Summary

In relation to the construction phase the potential impact on the soils, geology and hydrogeology is considered to be **short term - moderate**. This is because of the potential for spillages and soil stripping and subsoil removal that may be required and potential dewatering during the founding level of the proposed bridge structure.

9.5.2 Operational Phase

There will be no direct discharges to the water or soil environment during the operational phase.

Accidental Spills and Leaks

Due to the vulnerable nature of the underlying gravel and bedrock aquifer, road surface run-off containing pollutants such as oils and heavy metals or substances used during the maintenance of roads (such as chemical de-icers and herbicides) have the potential to impact on groundwater quality by causing pollution.

There is a potential for leaks and spillages during operation of the road. Any accidental emissions of chemicals or oil, petrol or diesel leaks could cause contamination if the emissions enter the soil and groundwater environment. Accidental spills and leaks could impact the underlying groundwater in the gravel and bedrock aquifer.

Soil Compaction

Raising of the ground level will be required along much of the route. The ground level will be raised by up to 6m to the east of the route (around CH1+260). Geological issues to be considered with regards to the raising of ground level include settlement of the existing ground profile, slope stability of the constructed embankments and determining a source for the material required.

Dewatering

Localised lowering of the water table may be required should the bridge structure require on-going dewatering. This could potentially result in loss or reduction of flow in in the gravel and possibly bedrock in the vicinity of the bridge structure. It is noted that there are no groundwater supply

boreholes in the vicinity of the bridge structure, however, the structure is located within the River Nore SPA.

Groundwater Recharge

There is the potential for a slight local reduction in groundwater recharge to the underlying gravel and bedrock aquifers along the line of the proposed route.

Summary

In relation to the operational phase the potential impact on the soils, geology and hydrogeology is considered to be **long term - slight**.

9.6 Mitigation Measures

In order to minimise the potential impacts from the development, the following mitigation measures will be implemented to ensure that soils and groundwater are not adversely impacted:

9.6.1 Construction Phase

Accidental Spills and Leaks

To minimise any impact on the underlying subsurface strata from material spillages, all oils, solvents and paints used during construction will be stored within temporary bunded areas. Oil and fuel storage tanks shall be stored in designated areas, and these areas shall be bunded to a volume of 110% of the capacity of the largest tank/container within the bunded area(s) (plus an allowance of 30 mm for rainwater ingress). Drainage from the bunded area(s) shall be diverted for collection and safe disposal.

Refuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles, will take place in a designated area (where possible) of the site, which will be away from surface water gulleys or drains. In the event of a machine requiring refuelling outside of this area, fuel will be transported in a mobile double skinned tank. An adequate supply of spill kits and hydrocarbon adsorbent packs will be stored in this area. All relevant personnel will be fully trained in the use of this equipment. Guidelines such as “Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors” (CIRIA 532, 2001)7 will be referred to.

Surface Water Runoff

Surface water runoff will not be discharged directly to local drains. During the construction phase, any runoff carrying a high sediment load will be diverted through a settlement trap (or similar) before discharge to ground. A settlement trap (or similar) works by channelling the runoff specifically to allow any suspended solids to settle before discharge. The settlement traps will be inspected regularly and immediately after heavy rainfall events.

Soil Removal and Compaction

Construction works will be carried out in such a manner as to ensure the least feasible disturbance of soils and subsoils. Where soil stripping and cutting are required, the resulting excavated material will be separated into topsoil and subsoil stockpiles.

Temporary storage of any spoil will be carefully managed in such a way as to prevent any potential negative impact on the receiving environment and the material will be stored away from any surface water drains.

Temporary access roads will be constructed for the delivery and removal of materials to the site. Topsoil will be removed and stored in advance of construction of temporary access roads. On completion the ground will be restored before reinstating the topsoil and seeding.

Suitable methods will be used where the ground levels are to be increased such that ground settlement and slope stability are addressed. Measures to address slope stability include the use of control drainage (herringbone drains) on embankment slopes, the use of geotextiles and soil stabilisation where required. Similar appropriate measures will be used to stabilise cut slopes.

Dewatering

The migration of fines during dewatering activities will be mitigated by the appropriate design and location of abstraction points. Where boreholes are used, the appropriate filter pack will be used and where interceptor drains are used, natural filter material or an appropriate geotextile will be used to control the migration of fines.

Depending on the scale of dewatering required during the construction of the bridge structure, which is within the River Nore SPA, further evaluation of the impact of the dewatering may be required. Water level monitoring devices may be installed and monitoring undertaken prior to and during construction. Suitable construction methods will be used to minimise the impact on the water table in these areas.

Summary

Implementation of the above mitigation measures during the construction phase will reduce the potential impact soils, geology and hydrogeology from short term - moderate to short term - imperceptible.

9.6.2 Operational Phase

Accidental Spills and Leaks

De-icers and herbicides will be applied according to manufacturer's instructions having particular regard to application rates.

Suitable drainage will be provided to intercept and divert run-off. Site runoff shall be contained and treated. Settlement ponds, silt traps and interceptor drains will be employed to reduce the amount of surface runoff from the site and to trap silt before discharge to surface waters.

An emergency plan will be in place for containing accidental spillages.

Dewatering

The migration of fines during dewatering activities will be mitigated by the appropriate design and location of abstraction points. Where boreholes are used, the appropriate filter pack will be used and where interceptor drains are used, natural filter material or an appropriate geotextile will be used to control the migration of fines.

Depending on the scale of any dewatering required during operation in the vicinity of the bridge structure which is within the Nore River SPA, further evaluation of the impact of the dewatering may be required. Water level monitoring devices may be installed and monitoring undertaken prior to and during construction. Suitable construction methods will be used to minimise the impact on the water table in these areas.

9.7 Residual Impacts

The proposed development will have a short term - imperceptible residual impact on soils, geology and hydrogeology due to the implementation of the mitigation measures outlined in the previous sections. Accordingly, there will be no negative impact (either short term, long term, direct or indirect) as a result of this proposed route on the surrounding soils, geology and hydrogeology environment.

9.8 Interaction and Inter-relationships with other Environmental Effects

Soils and geology will interact and/or interrelate with:

- Ecology: The loss of some areas of soil and rock types may impact on the ecology of the area. There are clear interactions between ecological receptors and water resource features. This issue is discussed in more detail in Chapter 7 – Flora and Fauna.
- Noise: Earthworks will involve the use of heavy plant and machinery that may result in noise and dust and vibration issues. These issues are discussed in Chapter 11 of this document.

9.9 Monitoring

Surface water will be monitored during construction to ensure current water quality is maintained as described in Chapter 7.

9.10 Reinstatement

Not applicable.

9.11 Difficulties Encountered in Compiling this Information

No difficulties were encountered.

10.0 AIR QUALITY AND CLIMATE

10.1 Introduction and Methodology

This chapter of the EIS assesses the impacts on air quality and climate associated with both the constructional and operational phases of the proposed Kilkenny Northern Ring Road Extension. The legislative air quality background of relevance to the Proposed Road Scheme is summarized below.

10.1.1 Ambient Air Quality Standards

In order to reduce the risk to health from poor air quality, national and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values or "Air Quality Standards" are health- or environmental-based levels for which additional factors may be considered. For example, natural background levels, environmental conditions and socio-economic factors may all play a part in the limit value which is set (see Tables 10.1 - 10.2 and Appendix L).

Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. The applicable standards in Ireland include the *Air Quality Standards Regulations 2011*, which incorporate *European Commission Directive 2008/50/EC*, which has set limit values for the pollutants SO_2, NO_2, PM_{10}, benzene and CO (see Table 10.1). *Council Directive 2008/50/EC* combines the previous *Air Quality Framework Directive (96/62/EC)* and its subsequent daughter directives (including *1999/30/EC* and *2000/69/EC*). Provisions were also made for the inclusion of new ambient limit values relating to $PM_{2.5}$ (see Appendix L).

10.1.2 Climate Agreements

Ireland ratified the United Nations Framework Convention on Climate Change (UNFCCC) in April 1994 and the *Kyoto Protocol* in principle in 1997 and formally in May 2002 (Framework Convention on Climate Change, 1999 and Framework Convention on Climate Change, 1997). For the purposes of the European Union burden sharing agreement under Article 4 of the *Kyoto Protocol*, in June 1998, Ireland agreed to limit the net growth of the six Greenhouse Gases (GHGs) under the *Kyoto Protocol* to 13% above the 1990 level over the period 2008 to 2012 (ERM, 1998). The UNFCCC is continuing detailed negotiations in relation to GHGs reductions and in relation to technical issues such as emissions trading and burden sharing.

10.1.3 Gothenburg Protocol

In 1999, Ireland signed the *Gothenburg Protocol to the 1979 UN Convention on Long Range Transboundary Air Pollution*. The objective of the Protocol is to control and reduce emissions of Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_X), Volatile Organic Compounds (VOCs) and Ammonia (NH_3). To achieve the targets Ireland had, by 2010, to meet national emission ceilings of 42kt for SO_2 (67% below 2001 levels), 65kt for NO_X (52% reduction), 55kt for VOCs (37% reduction) and 116kt for NH_3 (6% reduction). *European Commission Directive 2001/81/EC*, the National Emissions Ceiling

Directive, prescribed the same emission limits. Emissions of SO_2 and NH_3 from the road traffic sector are insignificant accounting for less than 1.5% of total emissions in Ireland in 2001. Road traffic emissions of Nitrogen Oxides (NO_X) and Volatile Organic Compounds (VOCs) are important accounting for 37% and 38% respectively of total emissions of these pollutants in Ireland in 2001 (DEHLG, 2003). A National Programme for the progressive reduction of emissions of the four transboundary pollutants has been in place since April 2005 (DEHLG, 2004b). As stated in the Ireland's Environment 2012 (EPA, 2012a) Ireland complied with the emissions ceilings for SO_2, VOCs and NH_3 but failed to comply with the ceiling for NO_X (72.6 kilotonnes compared to a target of 65 kilotonnes) due to sustained emissions from road transport. Ireland was one of 13 EU countries which did not comply with the target values in 2010. The proposal to amend the National Emissions Ceiling Directive is still under preparation and should set emission ceilings to be respected by 2020 for the four currently regulated substances as well as for primary emissions of $PM_{2.5.}$

Table 10.1 – Air Quality Standards Regulations 2011 (based on *European Commission Directive 2008/50/EC*)

Pollutant	Regulation Note1	Limit Type	Margin of Tolerance	Value
Nitrogen Dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	40% until 2003 reducing linearly to 0% by 2010	200 µg/m^3 NO_2
		Annual limit for protection of human health	40% until 2003 reducing linearly to 0% by 2010	40 µg/m^3 NO_2
		Annual limit for protection of vegetation	None	30 µg/m^3 NO + NO_2
Lead	2008/50/EC	Annual limit for protection of human health	100%	0.5 µg/m^3
Sulphur dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	150 µg/m^3	350 µg/m^3
		Daily limit for protection of human health - not to be exceeded more than 3 times/year	None	125 µg/m^3
		Annual & Winter limit for the protection of ecosystems	None	20 µg/m^3
Particulate Matter (as PM_{10})	2008/50/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50%	50 µg/m^3 PM_{10}
		Annual limit for protection of human health	20%	40 µg/m^3 PM_{10}
$PM_{2.5}$ (Stage 1)	2008/50/EC	Annual limit for protection of human health	20% from June 2008. Decreasing linearly to 0% by 2015	25 µg/m^3 $PM_{2.5}$
$PM_{2.5}$ (Stage 2) Note 2	-	Annual limit for protection of human health	None	20 µg/m^3 $PM_{2.5}$
Benzene	2008/50/EC	Annual limit for protection of human health	100% until 2006 reducing linearly to 0% by 2010	5 µg/m^3
Carbon Monoxide	2008/50/EC	8-hour limit (on a rolling basis) for protection of human health	60%	10 mg/m^3 (8.6 ppm)

Note 1 EU 2008/50/EC – Clean Air For Europe (CAFÉ) Directive replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC

Note 2 EU 2008/50/EC states - *'Stage 2 — indicative limit value to be reviewed by the Commission in 2013 in the light of further information on health and environmental effects, technical feasibility and experience of the target value in Member States'.*

Table 10.2 – Previous European Union Air Standards

Pollutant	Regulation	Type	Period	Value
Nitrogen Dioxide	85/203/EEC	Limit Value	98th percentile of yearly mean hourly concentrations	200 µg/m^3
		Guide Value		135 µg/m^3
		Guide Value	50th percentile of yearly mean hourly concentrations	50 µg/m^3
Lead	82/884/EEC	Limit Value	Annual mean	2 µg/m^3
Sulphur dioxide	80/779/EEC	Limit Value	98th percentile of yearly mean hourly concentrations	250-350[Note 1] µg/m^3
		Limit Value	Winter (medium of daily values)	130 or 180[Note 1] µg/m^3
		Limit Value	One year (medium of daily values)	80 or 120[Note 1] µg/m^3
		Guide Value	98th percentile of yearly mean hourly concentrations	135 µg/m^3
		Guide Value	50th percentile of 1-hour means	50 µg/m^3
Smoke	80/779/EEC	Limit Value	One year (medium of daily values)	80 µg/m^3
		Limit Value	Winter (medium of daily values)	130 µg/m^3
		Limit Value	98th percentile of daily values	250 µg/m^3

Note 1 The lower daily values refer to the situation with corresponding high levels of black smoke.

10.1.4Local Air Quality Assessment

The air quality assessment has been carried out following procedures described in the publications by the EPA (EPA 2002, 2003) and using the methodology outlined in the guidance documents published by the UK DEFRA (UK DEFRA 2001, 2007, 2009a, 2009b; UK DETR 1998) and the NRA (NRA 2011). The assessment of air quality was carried out using a phased approach as recommended by the UK DEFRA (UK DEFRA 2009a). The phased approach recommends that the complexity of an air quality assessment be consistent with the risk of failing to achieve the air quality standards. In the current assessment, an initial scoping of possible key pollutants was carried out and the likely location of air pollution "hot-spots" identified. An examination of recent EPA and Local Authority data in Ireland (EPA 2012b, 2013), has indicated that SO_2, smoke and CO are unlikely to be exceeded at locations such as the current one and thus these pollutants do not require detailed monitoring or assessment to be carried out.

The current assessment thus focused firstly on identifying the existing baseline levels of NO_2, PM_{10}, $PM_{2.5}$, benzene and CO in the region of the Proposed Road Scheme, both currently (by analysis of suitable EPA monitoring data), and when the Proposed Road Scheme is opened (through modelling). Thereafter, the impact of the Proposed Road Scheme on air quality at the neighbouring sensitive receptors was determined relative to "do nothing" levels for the opening and design years (2019 and 2034). The assessment methodology involved air dispersion modelling using the UK DMRB Screening Model (UK DEFRA 2007) (Version 1.03c, July 2007), the NO_x to NO_2 Conversion Spreadsheet (UK DEFRA, 2012) (Version 3.2 (Released September 2012)) and followed guidance issued by the NRA (NRA 2011), UK DEFRA (UK DEFRA 2007, 2009a) and the EPA (EPA 2002, 2003). The inputs to the air dispersion model consist of information on road layouts, receptor locations, annual average daily traffic movements (AADT), annual average traffic speeds and background concentrations. Using this input data the model predicts ambient ground level concentrations at the worst-case sensitive receptors using generic meteorological data. This worst-case concentration is then added to the existing background concentration to give the worst-case predicted ambient concentrations. The worst-case ambient concentrations are then compared with the relevant ambient air quality standard to assess the compliance of the Proposed Road Scheme with these ambient air quality standards.

Although no relative impact, as a percentage of the limit value, is enshrined in EU or Irish Legislation, the NRA guidelines (NRA 2011) detail a methodology for determining air quality impact significance criteria for road schemes. The degree of impact is determined based on both the absolute and relative impact of the Proposed Road Scheme. The NRA significance criteria have been adopted for the Proposed Road Scheme and are detailed in Tables 10.3 - 10.5. The significance criteria are based on PM_{10}, $PM_{2.5}$ and NO_2 as these pollutants are most likely to exceed the limit values. However the criteria have also been applied to the predicted 8-hour CO and annual benzene concentrations for the purposes of this assessment.

Table 10.3 – Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations

Magnitude of Change	Annual Mean NO_2 / PM_{10}	No. days with PM_{10} concentration > 50 µg/m^3	Annual Mean $PM_{2.5}$
Large	Increase / decrease ≥4 µg/m^3	Increase / decrease >4 days	Increase / decrease ≥2.5 µg/m^3
Medium	Increase / decrease 2 - <4 µg/m^3	Increase / decrease 3 or 4 days	Increase / decrease 1.25 - <2.5 µg/m^3
Small	Increase / decrease 0.4 - <2 µg/m^3	Increase / decrease 1 or 2 days	Increase / decrease 0.25 - <1.25 µg/m^3
Imperceptible	Increase / decrease <0.4 µg/m^3	Increase / decrease <1 day	Increase / decrease <0.25 µg/m^3

Source: *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* - National Roads Authority (2011)

Table 10.4 – Air Quality Impact Significance Criteria For Annual Mean Nitrogen Dioxide and PM_{10} and $PM_{2.5}$ Concentrations at a Receptor

Absolute Concentration in Relation to Objective/Limit Value	Change in Concentration[Note 1]		
	Small	Medium	Large
Increase with Scheme			
Above Objective/Limit Value With Scheme (≥40 µg/m^3 of NO_2 or PM_{10}) (≥25 µg/m^3 of $PM_{2.5}$)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value With Scheme (36 - <40 µg/m^3 of NO_2 or PM_{10}) (22.5 - <25 µg/m^3 of $PM_{2.5}$)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value With Scheme (30 - <36 µg/m^3 of NO_2 or PM_{10}) (18.75 - <22.5 µg/m^3 of $PM_{2.5}$)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective/Limit Value With Scheme (<30 µg/m^3 of NO_2 or PM_{10}) (<18.75 µg/m^3 of $PM_{2.5}$)	Negligible	Negligible	Slight Adverse
Decrease with Scheme			
Above Objective/Limit Value With Scheme (≥40 µg/m^3 of NO_2 or PM_{10}) (≥25 µg/m^3 of $PM_{2.5}$)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value With Scheme (36 - <40 µg/m^3 of NO_2 or PM_{10}) (22.5 - <25 µg/m^3 of $PM_{2.5}$)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value With Scheme (30 - <36 µg/m^3 of NO_2 or PM_{10}) (18.75 - <22.5 µg/m^3 of $PM_{2.5}$)	Negligible	Slight Beneficial	Slight Beneficial
Well Below Objective/Limit Value With Scheme (<30 µg/m^3 of NO_2 or PM_{10}) (<18.75 µg/m^3 of $PM_{2.5}$)	Negligible	Negligible	Slight Beneficial

Note 1 Where the Impact Magnitude is Imperceptible, then the Impact Description is Negligible

Source: *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* - National Roads Authority (2011)

Table 10.5 – Air Quality Impact Significance Criteria For Changes to Number of Days with PM_{10} Concentration Greater than 50 µg/m^3 at a Receptor

Absolute Concentration in Relation to Objective/Limit Value	Change in Concentration[Note 1]		
	Small	Medium	Large
Increase with Scheme			
Above Objective/Limit Value With Scheme (≥35 days)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value With Scheme (32 - <35 days)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value With Scheme (26 - <32 days)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective/Limit Value With Scheme (<26 days)	Negligible	Negligible	Slight Adverse
Decrease with Scheme			
Above Objective/Limit Value With Scheme (≥35 days)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value With Scheme (32 - <35 days)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value With Scheme (26 - <32 days)	Negligible	Slight Beneficial	Slight Beneficial
Well Below Objective/Limit Value With Scheme (<26 days)	Negligible	Negligible	Slight Beneficial

Note 1 Where the Impact Magnitude is Imperceptible, then the Impact Description is Negligible

Source: *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* - National Roads Authority (2011)

10.1.5 Operational Phase - Regional Impact Assessment Including Climate

The impact of the Proposed Road Scheme at a national / international level has been determined using the procedures given by the NRA (NRA 2011) and the methodology provided in Annex 2 of the UK DMRB (UK DEFRA 2007). The assessment focused on determining the resulting change in emissions of CO, particulates (PM_{10}), volatile organic compounds (VOCs), nitrogen oxides (NO_x) and carbon dioxide (CO_2). The Annex provides a method for the prediction of the regional impact of emissions of these pollutants from road schemes. The inputs to the air dispersion model consist of information on road link lengths, AADT movements and annual average traffic speeds.

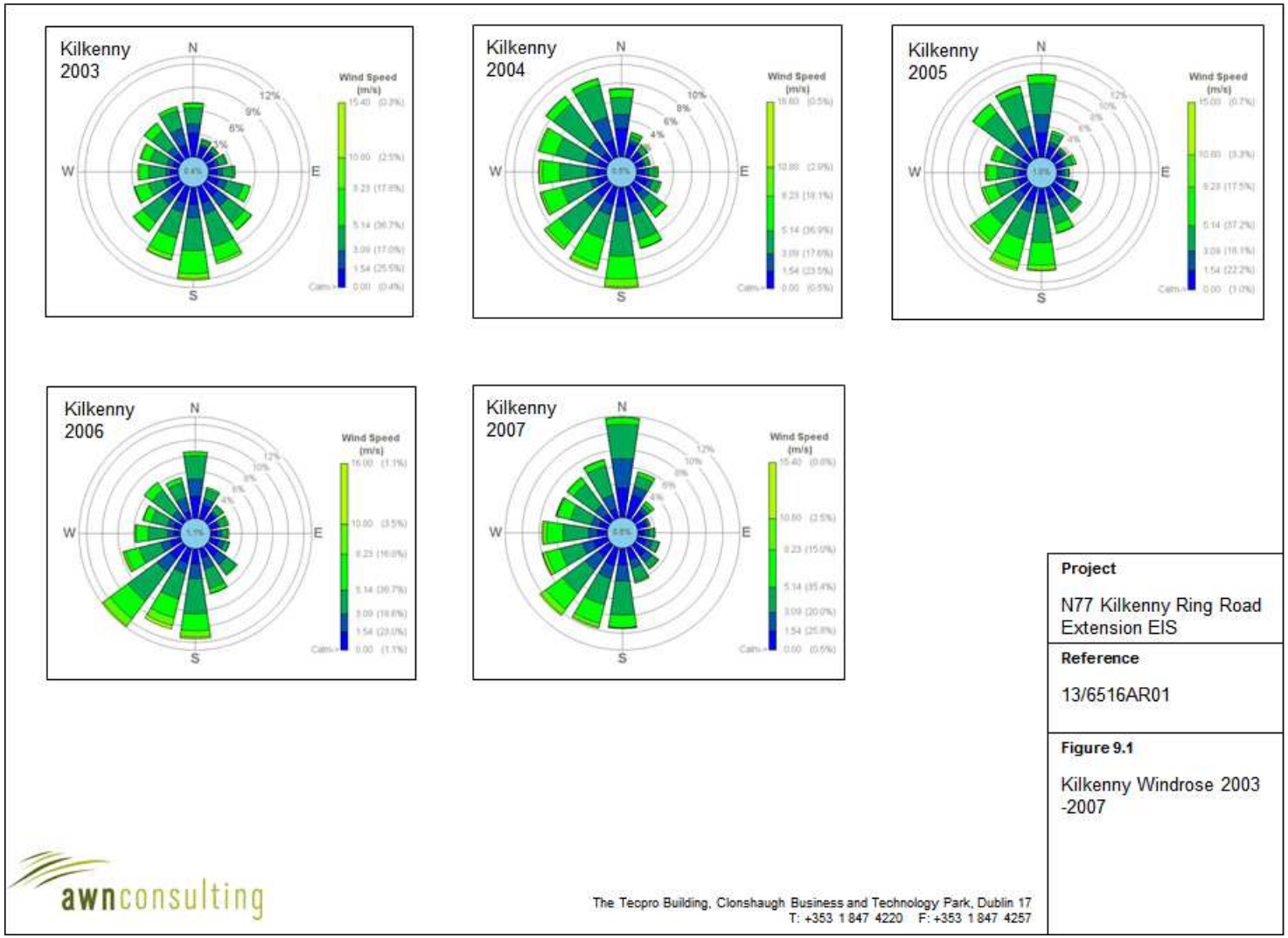
10.2 Description of Existing Conditions

10.2.1 Meteorological Data

A key factor in assessing temporal and spatial variations in air quality is the prevailing meteorological conditions. Depending on wind speed and direction, individual receptors may experience very significant variations in pollutant levels under the same source strength (i.e. traffic levels) (WHO 2006). Wind is of key importance in dispersing air pollutants and for ground level sources, such as traffic emissions, pollutant concentrations are generally inversely related to wind speed. Thus, concentrations of pollutants derived from traffic sources will generally be greatest under very calm conditions and low wind speeds when the movement of air is restricted. In relation to PM_{10}, the situation is more complex due to the range of sources of this pollutant. Smaller particles (less than $PM_{2.5}$) from traffic sources will be dispersed more rapidly at higher wind speeds. However, fugitive emissions of coarse particles ($PM_{2.5}$ - PM_{10}) will actually increase at higher wind speeds. Thus, measured levels of PM_{10} will be a non-linear function of wind speed.

The nearest representative weather station collating detailed weather records is Kilkenny meteorological station, which is located approximately 1 km south of the Proposed Road Scheme. For data collated during five representative years (2003 - 2007), the predominant wind direction ranges from northerly to southerly via westerly winds with an average wind speed of approximately 3 - 4 m/s.

Figure 10.1 – Windrose for Kilkenny Meteorological Station (2003 – 2007)



10.2.2Trends in Air Quality

Air quality is variable and subject to both significant spatial and temporal variation. In relation to spatial variations in air quality, concentrations generally fall significantly with distance from major road sources (UK DEFRA 2007). Thus, residential exposure in urban and suburban areas is determined by the location of sensitive receptors relative to major roads sources in the area. Temporally, air quality can vary significantly by orders of magnitude due to changes in traffic volumes, meteorological conditions and wind direction.

10.2.3Background Data

Air quality monitoring programs have been undertaken in recent years by the EPA and Local Authorities. The most recent annual report on air quality "Air Quality Monitoring Annual Report 2011" (EPA, 2012b), details the range and scope of monitoring undertaken throughout Ireland.

As part of the implementation of the Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002), four air quality zones have been defined in Ireland for air quality management and assessment purposes (EPA, 2012b). Dublin is defined as Zone A and Cork as Zone B. Zone C is composed of 21 towns with a population of greater than 15,000. The remainder of the country, which represents rural Ireland but also includes all towns with a population of less than 15,000, is defined as Zone D. In terms of air monitoring, the region of the Proposed Road Scheme is categorised as Zone C (EPA, 2012b).

Long-term NO_2 monitoring was carried out at one Zone C location in 2011, Limerick Park Road (EPA, 2012b). The NO_2 annual average in 2011 for this site was 12 µg/m^3. NO_2 monitoring was carried out at two urban Zone D locations, Castlebar and Shannon Town (EPA, 2012b). The NO_2 annual average in 2011 for both sites was 8 and 6 µg/m^3, respectively with no exceedances of the 1-hour limit value (EPA, 2012b). Hence, the long-term average concentrations measured at these locations were significantly lower than the annual average limit value of 40 µg/m^3. Based on the above information, a conservative estimate of the 2013 background NO_2 concentration for the region of the Proposed Road Scheme is 12 µg/m^3.

The results of CO monitoring carried out in Shannon Town (Zone D) and Old Station Road (Zone B) in 2011 showed no exceedences of the 8-hour limit value (EPA, 2012b), with average annual mean levels of 0.2 mg/m^3 and 0.3 mg/m^3, respectively (EPA, 2012b). The maximum 8-hour levels recorded at Shannon Town and Old Station Road in 2011 were 1.3 mg/m^3 and 2.7 mg/m^3 respectively (EPA, 2012b). Based on the above information, a conservative estimate of the long-term background CO concentration for the region of the Proposed Road Scheme in 2013 is 0.4 mg/m^3.

With regard to benzene, continuous monitoring was carried out at Shannon Town (Zone D) in 2011, with a long-term average of 0.4 µg/m^3 (EPA, 2012b). The results of monitoring carried out in the Zone D location of Emo Court in 2010 also indicated a long-term average of 0.4 µg/m^3 (EPA, 2012b).

Benzene monitoring carried out at the Zone B location of Old Station Road in 2011 had a long-term average of 2.0 µg/m^3 (EPA, 2012b). Based on the above information a conservative estimate of the background benzene concentration for the region of the Proposed Road Scheme in 2013 is 2.0 µg/m^3.

Long-term PM_{10} monitoring was carried out at four Zone C locations in 2011; Galway, Celbridge, Ennis and Bray (EPA, 2012b). The average concentrations measured at these sites ranged from 13 µg/m^3 in Bray to 24 µg/m^3 in Celbridge (EPA, 2012b). The urban Zone D locations of Castlebar, Claremorris and Shannon Town had average concentrations of 14, 12 and 11 µg/m^3, respectively in 2011. In addition, annual average PM_{10} levels at the urban background monitoring location in the Phoenix Park in 2011 was 12 µg/m^3, with only three exceedances of the 24-hour limit value of 50 µg/m^3 (EPA, 2012b). Based on the above information a conservative estimate of the 2013 background PM_{10} concentration, for the region of the Proposed Road Scheme which is defined as Zone C is 22 µg/m^3.

The results of $PM_{2.5}$ monitoring at Ennis (Zone C) in 2011 (EPA, 2012b) indicated an average $PM_{2.5}/PM_{10}$ ratio of 0.64. Based on this information, a conservative ratio of 0.65 was used to generate a background $PM_{2.5}$ concentration in 2012 of 14.3 µg/m^3.

Background concentrations for 2019 and 2034 were calculated from the 2013 background concentrations using the Netcen background calculator, which uses year on year reduction factors provided by UK DEFRA (UK DEFRA 2009a). A summary of the background concentrations used for the DMRB air dispersion model is detailed in Table 10.6.

Table 10.6 – Summary of background concentrations used in the DMRB air dispersion model

Background Values	Nitrogen Oxides (µg/m^3)	Nitrogen Dioxide (µg/m^3)	Benzene (µg/m^3)	Particulates (PM_{10}) (µg/m^3)	Particulates ($PM_{2.5}$) (µg/m^3)[Note 2]	Carbon Monoxide (mg/m^3)
Year 2013	15.3	12.0	2.00	22.0	14.3	0.40
Year 2019 [Note 1]	14.9	11.6	2.05	21.4	13.9	0.40
Year 2034 [Note 1]	14.8	11.6	2.10	21.3	13.8	0.42

Note 1 Reduction in future years using the Netcen background calculator (November 2002) and Netcen background calculator 2.2a (January 2006).

Note 2 A ratio of 0.65 has been used for the ratio of $PM_{2.5}$ / PM_{10}.

10.3 Characteristics of Proposed Road Scheme

10.3.1 Operational Phase

Road traffic is expected to be the dominant source of emissions resulting from the Proposed Road Scheme. Road traffic would also be expected to be the dominant source of greenhouse gas emissions resulting from the Proposed Road Scheme.

10.4 Predicted Impacts of the Proposed Road Scheme

10.4.1 Construction Phase

The greatest potential impact on air quality during the construction phase of the Proposed Scheme is from construction dust emissions and the potential for nuisance dust.

While construction dust tends to be deposited within 200m of a construction site, the majority of the deposition occurs within the first 50m. Most importantly, if the dust minimisation measures specified in Section 10.5.1 of this chapter are implemented, fugitive emissions of dust from the site will be insignificant and pose no nuisance at nearby receptors.

Due to the size and nature of the construction activities, CO_2 and N_2O emissions during construction will have a negligible impact on climate.

10.4.2 Operational Phase – Local Air Quality

Detailed traffic flow information was obtained from the traffic consultant for the Project and has been used to model pollutant levels under various traffic scenarios and under sufficient spatial resolution to assess whether any significant air quality impact on sensitive receptors may occur. The traffic data corresponded to the design years of 2019 and 2034. The traffic data used represented figures for the "do nothing" (i.e. without the Proposed Road Scheme in place) and "do something" (i.e. with the Proposed Road Scheme in place) scenarios.

Cumulative effects have been assessed, as recommended in the EU Directive on EIA (Council Directive 97/11/EC) and using the methodology of the UK DEFRA (UK DEFRA 2009a, UK DETR 1998). Firstly, background concentrations (UK DEFRA 2009a) have been included in the modelling study, for both "do nothing" and "do something" scenarios. These background concentrations are year-specific and account for non-localised sources of the pollutants of concern (UK DEFRA 2009a). Appropriate background levels were selected based on the available monitoring data provided by the EPA and Local Authorities (EPA 2012b, 2013) (see section 10.2.3).

Once appropriate background concentrations were established, the existing situation, including background levels, was assessed in the absence of the Proposed Road Scheme for the opening and design years. The assessment methodology involved air dispersion modelling using the UK DMRB Screening Model (Version 1.03c) (UK DEFRA 2007), the NO_x to NO_2 Conversion Spreadsheet (UK DEFRA, 2012) (Version 3.2 (Released September 2012)) and followed guidance issued by the UK DEFRA (UK DETR 1998; UK DEFRA 2007, 2009a, 2009b). Ambient concentrations of CO, benzene, NO_2, PM_{10} and $PM_{2.5}$ for 2019 and 2034 were predicted at the nearest sensitive receptors to the Proposed Road Scheme. "Do nothing" and "do something" modelling was carried out at the building façade of the worst-case receptors for both 2019 and 2034. This assessment allows the significance

of the Proposed Road Scheme, with respect to both relative and absolute impact, to be determined both temporally and spatially.

Receptor Locations

Eight locations were modelled close to the route of the Proposed Road Scheme. The receptors modelled represent the worst-case locations and were chosen due to their close proximity to the Proposed Road Scheme. Details of the assessment locations are provided in Table 10.7.

Annual average traffic speeds are required as an input to the DMRB screening model (UK DEFRA 2007). The Proposed Road was modelled at a speed of 100 kph.

Table 10.7 – DMRB Screening Air Quality Assessment, Proposed Northern Ring Road Extension. Details of Assessment Locations

Receptor No.	Location / Townland	Approximate Chainage	Irish Grid Co-ordinates
1	Tomona 1	NA	249115 159013
2	Tomona 2	NA	249030 158828
3	Tomona 3	0	249048 158685
4	Oldpark	NA	249262 158441
5	Hospital	280	249372 158685
6	Loughmerans	620	249681 159050
7	The Court (Weir View)	1390	250423 158600
8	Glendine	NA	250552 158578

Modelling Results and Impact Assessment

CO and Benzene

The results of the modelled impact of the Proposed Road for CO and benzene in the opening and design years are shown in Tables 10.8 - 10.9. Predicted pollutant concentrations with the Proposed Road Scheme in place are below the ambient standards at all locations. Levels of both pollutants range from 20 - 42% of the respective limit values in 2019.

Future trends indicate similarly low levels of CO and benzene. Levels of both pollutants are below the relevant limit values, ranging from 21 - 44% of their respective limits in 2034.

The impact of the Proposed Road Scheme can be assessed relative to “do nothing” levels in 2019 and 2034 (see Tables 10.8 - 10.9). Relative to baseline levels, some small increases in pollutant levels at the worst-case receptors are predicted as a result of the Proposed Road Scheme. With regard to impacts at individual receptors, none of the 8 receptors assessed will experience an increase in concentrations of greater than 5% of the limit value in either 2019 or 2034 and thus the magnitude of

the changes in air quality are either small or imperceptible at all receptors based on the criteria outlined in Table 10.3.

The greatest impact on CO and benzene concentrations in either 2019 or 2034 will be an increase of 1.2% of their respective limit values.

Thus, using the assessment criteria outlined in Tables 10.3 and 10.4, and applying these criteria to CO and benzene, the impact of the Proposed Road Scheme in terms of CO and benzene is negligible.

Table 10.8 – DMRB Screening Air Quality Assessment, Proposed Northern Ring Road Extension. Predicted Maximum 8-Hour CO Concentrations.

Receptor	Location	Maximum 8-Hour CO Concentrations (mg/m^3)			
		Do Nothing		*Do Something*	
		2019	*2034*	*2019*	*2034*
1	Tomona 1	2.1	2.2	2.1	2.2
2	Tomona 2	2.1	2.2	2.1	2.2
3	Tomona 3	2.1	2.2	2.1	2.3
4	Oldpark	2.1	2.3	2.2	2.4
5	Hospital	2.0	2.1	2.1	2.2
6	Loughmerans	2.0	2.1	2.0	2.1
7	The Court (Weir View)	2.0	2.1	2.0	2.1
8	Glendine	2.2	2.3	2.2	2.4
Ambient Limit Value[Note 1]		10 mg/m^3	10 mg/m^3	10 mg/m^3	10 mg/m^3

Note 1 Maximum 8-hour CO Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC

Table 10.9 – DMRB Screening Air Quality Assessment, Proposed Northern Ring Road Extension. Predicted Annual Mean Benzene Concentrations.

Receptor	Location	Annual Mean Benzene Concentrations (g/m^3)			
		Do Nothing		*Do Something*	
		2019	*2034*	*2019*	*2034*
1	Tomona 1	2.07	2.13	2.07	2.13
2	Tomona 2	2.07	2.13	2.07	2.12
3	Tomona 3	2.07	2.12	2.07	2.13
4	Oldpark	2.08	2.14	2.10	2.18
5	Hospital	2.05	2.10	2.06	2.12
6	Loughmerans	2.05	2.10	2.05	2.10
7	The Court (Weir View)	2.05	2.10	2.06	2.11
8	Glendine	2.09	2.15	2.10	2.16
Ambient Limit Value[Note 1]		5 □g/m^3	5 □g/m^3	5 □g/m^3	5 □g/m^3

Note 1 Annual Average Benzene Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC

PM_{10}

The results of the modelled impact of the Proposed Road Scheme for PM_{10} in the opening and design years are shown in Table 10.10. Predicted annual average concentrations are below the ambient standards at all worst-case receptors, ranging from 53 - 55% of the limit value in 2019. In addition, there were at most 6 exceedances of the 24-hour PM_{10} concentration at any of the locations (35 exceedances are permitted per year).

Future trends with the Proposed Road Scheme in place indicate similarly low levels of PM_{10}. Annual average PM_{10} concentrations range from 53 - 56% of the limit in 2034. Furthermore, the results show that the 24-hour limit value was exceeded only 7 times in 2034.

The impact of the Proposed Road Scheme can be assessed relative to "do nothing" levels in 2019 and 2034 (see Table 10.10). Relative to baseline levels, some small increases in PM_{10} levels at the worst-case receptors are predicted as a result of the Proposed Road Scheme. With regard to impacts at individual receptors, none of the 8 receptors assessed will experience an increase in concentrations of over 5% of the limit value in either 2019 or 2034 and thus the magnitude of the changes in air quality are either small or imperceptible at all receptors based on the criteria outlined in Table 10.3.

The greatest impact on PM_{10} concentrations in the region of the Proposed Road Scheme in either 2019 or 2034 will be an increase of 1.8% of the annual limit value.

Thus, using the assessment criteria outlined in Tables 10.3 - 10.5, the impact of the Proposed Road Scheme with regard to PM_{10} is negligible.

Table 10.10 – DMRB Screening Air Quality Assessment, Proposed Northern Ring Road Extension. Predicted Annual Mean PM_{10} Concentrations.

Receptor	Location	Annual Mean PM_{10} Concentrations (g/m^3)			
		Do Nothing		*Do Something*	
		2019	*2034*	*2019*	*2034*
1	Tomona 1	21.7	21.7	21.7	21.7
2	Tomona 2	21.6	21.7	21.6	21.6
3	Tomona 3	21.6	21.6	21.9	22.0
4	Oldpark	21.8	21.9	22.0	22.3
5	Hospital	21.4	21.3	21.8	22.0
6	Loughmerans	21.4	21.3	21.3	21.3
7	The Court (Weir View)	21.4	21.3	21.6	21.6
8	Glendine	22.0	22.1	22.2	22.4
Ambient Limit Value[Note 1]		40 µg/m^3	40 µg/m^3	40 µg/m^3	40 µg/m^3

Note 1 Annual Average PM_{10} Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC

$PM_{2.5}$

The results of the modelled impact of the Proposed Road Scheme for $PM_{2.5}$ in the opening and design years are shown in Table 10.11. Predicted annual average concentrations are below the ambient standards at all worst-case receptors, ranging from 55 - 59% of the limit value in 2019.

Future trends with the Proposed Road Scheme in place indicate similarly low levels of $PM_{2.5}$. Annual average $PM_{2.5}$ concentrations range from 55 - 60% of the limit in 2034.

The impact of the Proposed Road Scheme can be assessed relative to "do nothing" levels in 2019 and 2034 (see Table 10.11). Relative to baseline levels, some small increases in $PM_{2.5}$ levels at the worst-case receptors are predicted as a result of the proposed road. With regard to impacts at individual receptors, none of the 8 receptors assessed will experience an increase in concentrations of over 5% of the limit value in either 2019 or 2034 and thus the magnitude of the changes in air quality are either small or imperceptible at all receptors based on the criteria outlined in Table 10.3.

The greatest impact on $PM_{2.5}$ concentrations in the region of the Proposed Road Scheme in either 2019 or 2034 will be an increase of 2.9% of the annual limit value.

Thus, using the assessment criteria outlined in Tables 10.3 and 10.4, the impact of the Proposed Road Scheme with regard to $PM_{2.5}$ is negligible at all 8 of the receptors assessed.

Table 10.11 – DMRB Screening Air Quality Assessment, Proposed Northern Ring Road Extension. Predicted Annual Mean $PM_{2.5}$ Concentrations.

Receptor	Location	Annual Mean $PM_{2.5}$ Concentrations (g/m^3)			
		Do Nothing		*Do Something*	
		2019	***2034***	***2019***	***2034***
1	Tomona 1	14.2	14.3	14.2	14.3
2	Tomona 2	14.1	14.2	14.1	14.2
3	Tomona 3	14.1	14.2	14.4	14.6
4	Oldpark	14.3	14.4	14.6	14.9
5	Hospital	13.9	13.8	14.3	14.6
6	Loughmerans	13.9	13.8	13.9	13.8
7	The Court (Weir View)	13.9	13.9	14.1	14.2
8	Glendine	14.5	14.6	14.7	15.0
Ambient Limit Value[Note 1]		25 µg/m^3	25 µg/m^3	25 µg/m^3	25 µg/m^3

Note 1 Annual Average $PM_{2.5}$ Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC

NO_2

The result of the assessment of the impact of the Proposed Road Scheme for NO_2 in the opening and design years are shown in Tables 10.12 - 10.13. The annual average concentration is within the limit value at all worst-case receptors. Future trends, with the Proposed Road Scheme in place, indicate similarly low levels of NO_2. Levels of NO_2 range from 29 – 43% of the annual limit value in 2019 and 2034.

Maximum one-hour NO_2 levels with the Proposed Road Scheme in place will be significantly below the limit value, with levels at the worst-case receptor reaching 40% of the limit value in 2019 and 43% of the limit in 2034.

The impact of the Proposed Road Scheme on maximum one-hour NO_2 levels can be assessed relative to "do nothing" levels in 2019 and 2034 (see Tables 10.12 – 10.13). Relative to baseline levels, some increases in pollutant levels are predicted as a result of the Proposed Road Scheme. For the opening year of 2019, none of the 8 worst-case receptors assessed will experience increased levels of over 5% of the limit value. For the design year of 2034, of the 8 worst-case receptors assessed, one receptor (Receptor 5) will experience increased levels of over 5% of the limit value. The remaining seven receptors will experience an increase in levels of less than 5% of the limit value.

The greatest impact on NO_2 concentrations in the region of the Proposed Road Scheme in either 2019 or 2034 will be an increase of 7.1% of the annual or maximum 1-hour limit value.

Thus, using the assessment criteria outlined in Tables 10.3 - 10.4, the impact of the Proposed Road Scheme in terms of NO_2 is negligible at all 8 receptors assessed in both 2019 and 2034.

Table 10.12 – DMRB Screening Air Quality Assessment, Proposed Northern Ring Road Extension. Predicted Annual Average NO_2 Concentrations.

Receptor	Location	Annual Average NO_2 Concentrations ($\mu g/m^3$)			
		Do Nothing		*Do Something*	
		2019	*2034*	*2019*	*2034*
1	Tomona 1	13.3	13.8	13.3	13.7
2	Tomona 2	13.1	13.5	13.1	13.4
3	Tomona 3	13.0	13.4	14.1	15.0
4	Oldpark	14.0	14.7	15.3	16.6
5	Hospital	11.6	11.6	13.6	14.5
6	Loughmerans	11.6	11.6	11.6	11.6
7	The Court (Weir View)	11.7	11.7	12.6	12.9
8	Glendine	14.8	15.5	16.0	17.0
Ambient Limit Value[Note 1]		40 $\mu g/m^3$	40 $\mu g/m^3$	40 $\mu g/m^3$	40 $\mu g/m^3$

Note 1 Annual Average NO_2 Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC

Table 10.13 – DMRB Screening Air Quality Assessment, Proposed Northern Ring Road Extension. Details Predicted Maximum 1-Hour NO_2 Concentrations.

Receptor	Location	Maximum 1-Hour NO_2 Concentrations ($\mu g/m^3$)			
		Do Nothing		*Do Something*	
		2019	*2034*	*2019*	*2034*
1	Tomona 1	66.5	69.1	66.5	68.6
2	Tomona 2	65.3	67.5	65.3	67.1
3	Tomona 3	65.0	67.0	70.7	74.8
4	Oldpark	69.9	73.4	76.6	83.2
5	Hospital	58.2	58.2	68.0	72.3
6	Loughmerans	58.2	58.2	58.2	58.2
7	The Court (Weir View)	58.6	58.7	62.8	64.7
8	Glendine	74.2	77.7	79.8	85.0
Ambient Limit Value[Note 1]		200 $\mu g/m^3$	200 $\mu g/m^3$	200 $\mu g/m^3$	200 $\mu g/m^3$

Note 1 Maximum 1-Hour NO_2 Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC (as a 99.8th%ile)

"Do Nothing" Scenario – Local Air Quality

CO and Benzene

The results of the "do nothing" modelling assessment for CO and benzene in the opening and design years are shown in Tables 10.8 – 10.9. Concentrations are well within the limit values at all worst-case receptors. Levels of both pollutants range from 20 - 43% of the respective limit values in 2019 and 2034.

PM_{10}

The results of the "do nothing" modelling assessment for PM_{10} in the opening and design years are shown in Table 10.10. Predicted annual average concentrations are below the ambient standards at all worst-case receptors, ranging from 53 - 55% of the annual limit value in 2019 and 2034. In addition, there were only 6 exceedances of the 24-hour PM_{10} concentration at any receptor.

$PM_{2.5}$

The results of the "do nothing" modelling assessment for $PM_{2.5}$ in the opening and design years are shown in Tables 10.11. Predicted annual average concentrations are below the ambient standards at all worst-case receptors, ranging from 55 - 58% of the annual limit value in 2019 and 2034.

NO_2

The results of the "do nothing" assessment of annual average and maximum 1-hour NO_2 concentrations in the opening and design years are shown in Tables 10.12 – 10.13. Predicted levels are within the limit values at all worst-case receptors, ranging from 29 - 39% of the annual limit value in 2019 and 2034.

10.4.3 Operational Phase – Air Quality Impacts on Sensitive Ecosystems

The EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (the "Habitats Directive") requires an Appropriate Assessment to be carried out where there is likely to be a significant impact upon a European protected site. Such sites include Natural Heritage Areas (NHA), Special Areas of Conservation (SAC), Special Protection Areas (SPA), National Parks, Nature Reserves, Refuges for Fauna, Refuges for Flora, Wildfowl Sanctuaries, Ramsar Sites, Biogenetic Reserves and UNESCO Biosphere Reserves.

The NRA guidelines (NRA 2011) state that as the potential impact of a scheme is limited to a local level, detailed consideration need only be given to roads where there is a significant change to traffic flows (>5%) and the designated site lies within 200m of the road centre line.

The impact of NO_x (i.e. NO and NO_2) emissions resulting from the proposed road at the Dunmore Complex pNHA, River Barrow and River Nore cSAC and River Nore SPA was assessed. The proposed road traverses the three designated sites. Dispersion modelling and prediction was carried out at typical traffic speeds. Ambient NO_x concentrations predicted for the opening and design years along a transect of up to 200m within the Dunmore Complex pNHA, River Barrow and River Nore cSAC and River Nore SPA are given in Table 10.14. The road contribution to dry deposition along the transect is also given and was calculated using the methodology of the NRA (NRA 2011).

The predicted annual average NO_x level in the Dunmore Complex pNHA, River Barrow and River Nore cSAC and River Nore SPA is below the limit value of 30 µg/m^3 for the “do minimum” scenario in 2019 and 2034, with NO_x concentrations reaching 50% of this limit in 2019 and 49% in 2034. Levels are increased with the Proposed Road Scheme in place, reaching 81% of the limit value for the “do something” scenario in 2019 and 97% of the limit value in 2034.

The impact of the Proposed Scheme leads to an increase in NO_x concentrations of up to 14.3 µg/m^3 within the Dunmore Complex pNHA, River Barrow and River Nore cSAC and River Nore SPA. The NRA guidelines state in Appendix 2 that where the scheme is expected to cause an increase of more than 2 µg/m^3 and the predicted concentrations (including background) are close to, or exceed the standard, then the sensitivity of the habitat to NO_X should be assessed by the project ecologist.

The road contribution to the NO_2 dry deposition rate along the 200m transect within the Dunmore Complex pNHA, River Barrow and River Nore cSAC and River Nore SPA is also detailed in Table 10.14. The maximum increase in the NO_2 dry deposition rate is 0.49 Kg(N)/ha/yr in 2019 and 0.43 Kg(N)/ha/yr in 2034. This reaches only 9.8% of the critical load for inland and surface water habitats of 5-10 Kg(N)/ha/yr (NRA 2011).

Table 10.14 – Air Quality Assessment of Ecosystems, Proposed Northern Ring Road Extension. Assessment of Impact Along Transect From Proposed Road Through the Dunmore Complex pNHA, River Barrow and River Nore cSAC, and River Nore SPA.

Dist. To Road (m)[Note 1]	NO_x Conc. (µg/m^3) - 2019			NO_x Conc. (µg/m^3) - 2034			NO_2 Dry Deposition Rate Impact (Kg(N) /ha/yr)	
	Do Minimum	Do Something	Impact	Do Minimum	Do Something	Impact	2019	2034
10	14.9	24.44	9.8	14.8	29.1	14.3	0.49	0.43
20	14.9	22.12	7.4	14.8	25.6	10.8	0.37	0.33
30	14.9	20.44	5.7	14.8	23.1	8.3	0.28	0.26
40	14.9	19.22	4.4	14.8	21.3	6.5	0.22	0.21
50	14.9	18.29	3.5	14.8	19.9	5.1	0.17	0.17
60	14.9	17.57	2.7	14.8	18.8	4.0	0.13	0.13
70	14.9	17.01	2.2	14.8	18.0	3.2	0.10	0.10
80	14.9	16.56	1.7	14.8	17.3	2.5	0.08	0.08
90	14.9	16.20	1.3	14.8	16.7	1.9	0.06	0.07
100	14.9	15.91	1.0	14.8	16.3	1.5	0.05	0.05
110	14.9	15.69	0.8	14.8	16.0	1.2	0.03	0.04
120	14.9	15.52	0.6	14.8	15.7	0.9	0.03	0.03
130	14.9	15.39	0.5	14.8	15.5	0.7	0.02	0.02
140	14.9	15.29	0.4	14.8	15.4	0.6	0.01	0.02
150	14.9	15.23	0.3	14.8	15.3	0.5	0.01	0.02
160	14.9	15.20	0.3	14.8	15.3	0.5	0.01	0.02
170	14.9	15.18	0.3	14.8	15.2	0.4	0.01	0.01
180	14.9	15.14	0.2	14.8	15.2	0.4	0.01	0.01
190	14.9	15.09	0.2	14.8	15.1	0.3	0.00	0.01
200	14.9	15.05	0.2	14.8	15.0	0.2	0.00	0.01
Standards	30 µg/m^3	30 µg/m^3	-	30 µg/m^3	30 µg/m^3	-	5 - 10 Kg(N)/ha/yr	

10.4.4 Operational Phase - Regional Air Quality

The regional impact of the Proposed Road on emissions of NO_x and VOCs has been assessed using the procedures of the NRA (NRA 2011) and the UK DEFRA (UK DEFRA 2007) using the DMRB screening model (V1.03c, July 2007). The results (see Table 10.15) indicate that the impact of the Proposed Road Scheme on Ireland's obligations under the Gothenburg Protocol is negligible. For the assessment year of 2019, the predicted impact of the proposed road is to increase NO_x levels by 0.004% of the NO_x emissions ceiling and increase VOC levels by 0.001% of the VOC emissions ceiling which was to be complied with in 2010. For the assessment year of 2034, the predicted impact of the proposed road is to increase NO_x levels by 0.008% of the NO_x emissions ceiling and increase VOC levels by 0.002% of the VOC emissions ceiling which was to be complied with in 2010.

"Do-Nothing" Scenario - Regional Air Quality

Predicted "do nothing" emissions of NO_x and VOCs in the region of the Proposed Road Scheme are provided in Table 10.15. NO_x and VOC emissions in the region of the Proposed Road Scheme represent at most 0.006% and 0.002% respectively of the national emissions ceilings in 2019 and 2034.

10.4.5 Operational Phase - Climate

The impact of the operational phase of the Proposed Road Scheme on emissions of CO_2 was also assessed using the DMRB screening model (see Table 10.15). The results show that the impact of the Proposed Road Scheme will be to increase CO_2 emissions by 0.002% of Ireland's Kyoto target in 2019 and 0.004% in 2034. Thus, the impact of the Proposed Road Scheme on national greenhouse gas emissions will be negligible in terms of Ireland's obligations under the Kyoto Protocol (FCCC 1997, DEHLG 2007b).

"Do-Nothing" Scenario - Climate

Predicted "do nothing" emissions of CO_2 in the region of the Proposed Road are provided in Table 10.15. CO_2 emissions represent at most 0.003% of Ireland's limits under the Kyoto Protocol (FCCC 1997, DEHLG 2007b).

10.4.6 Worst Case Scenario

The worst-case scenario corresponds to the situation where the mitigation measures fail or are not implemented. Should dust mitigation measures not be implemented during the construction phase, significant dust nuisance is likely in areas close to the construction site. Furthermore, there is also the potential for exceedances of the PM_{10} and $PM_{2.5}$ air quality standards during the construction period. The results of the air dispersion modelling assessment show that no mitigation measures are required during the operational phase and therefore the worst-case scenario is not applicable.

Table 10.15 – Regional Air Quality Assessment. Proposed Northern Ring Road Extension

Year	Scenario	CO (kg/annum)	VOC (kg/annum)	NO_X (kg/annum)	PM_{10} (kg/annum)	CO_2 (tonnes/annum)
2019	Do Nothing	5,935	736	2,942	90	1,530
	Do Something	9,867	1,216	5,738	193	2,875
2034	Do Nothing	7,336	912	3,581	114	1,889
	Do Something	14,459	1,784	8,491	302	4,283
Increment in 2019		3,932	480	2,796	103	1,345
Increment in 2034		7,123	872	4,910	188	2,394
Emission Ceiling			55 kt[Note 1]	65 kt[Note 1]		62,800 kt[Note 2]
Impact in 2019			0.001%	0.004%		0.002%
Impact in 2034			0.002%	0.008%		0.004%

Note 1 kt = kilo tonnes. National Emission Ceiling (EU Directive 2001/81/EC)

Note 2 kt = kilo tonnes. Ireland's Target Under The Kyoto Protocol

10.5 Remedial and Mitigation Measures

10.5.1 Construction Phase

The potential for dust to be emitted depends on the type of construction activity being carried out in conjunction with environmental factors including levels of rainfall, wind speeds and wind direction. The potential for impact from dust depends on the distance to potentially sensitive locations and whether the wind can carry the dust to these locations. The majority of any dust produced will be deposited close to the potential source and any impacts from dust deposition will typically be within two hundred metres of the construction activities.

In order to minimise dust emissions during construction, a series of mitigation measures have been prepared for implementation during the construction phase of the project. These measures are as follows:

- Site roads will be regularly cleaned and maintained as appropriate. Hard surface roads will be swept to remove mud and aggregate materials from their surface while any unsurfaced roads will be restricted to essential site traffic only. Any road that has the potential to give rise to fugitive dust will be regularly watered during dry and/or windy conditions.
- Vehicles using site roads will have their speeds restricted where there is a potential for dust nuisance at nearby properties.
- Where practicable, vehicles exiting the site shall make use of a wheel wash facility prior to entering onto public roads. This will ensure that mud and other wastes are not tracked onto public roads. Public roads outside the site will be regularly inspected for cleanliness, and cleaned as necessary. Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions.
- Material handling systems and site stockpiling of materials will be designed and laid out to minimise exposure to wind. Water misting or sprays will be used as required if particularly dusty activities are necessary during dry or windy periods.
- The dust minimisation procedures put in place will be monitored and assessed in the event of dust nuisance occurring outside the site boundary, the effectiveness of existing measures will be reviewed and further mitigation will be implemented to rectify the problem.
- Provided the dust minimisation measures outlined above are adhered to, the air quality impacts during the construction phase will not be significant.

10.5.2 Operational Phase - Air Quality

Mitigation measures in relation to traffic-derived pollutants have focused generally on improvements in both engine technology and fuel quality. EU legislation, based on the EU sponsored Auto-Oil programmes, has imposed stringent emission standards for key pollutants (REGULATION (EC) No 715/2007) for passenger cars to be complied with in 2009 (Euro V) and 2014 (Euro VI). With regard to

heavy duty vehicles, EU Directive 2005/78/EC defines the emission standard currently in force, Euro IV, as well as the next stage (Euro V) which has entered into force since October 2009. In addition, it defines a non-binding standard called Enhanced Environmentally-friendly Vehicle (EEV). In relation to fuel quality, SI No. 407 of 1999 and SI No. 72 of 2000 have introduced significant reductions in both sulphur and benzene content of fuels.

In relation to design and operational aspects of road schemes, emissions of pollutants from road traffic can be controlled most effectively by either diverting traffic away from heavily congested areas or ensuring free flowing traffic through good traffic management plans and the use of automatic traffic control systems (UK DEFRA 2009b). Improvements in air quality are likely over the next few years as a result of the on-going comprehensive vehicle inspection and maintenance program, fiscal measures to encourage the use of alternatively fuelled vehicles and the introduction of cleaner fuels.

10.5.3 Operational Phase - Climate

CO_2 emissions for the average new car fleet were reduced to 120 g/km by 2012 through EU legislation on improvements in vehicle motor technology and by an increased use of biofuels. This measure was estimated to reduce CO_2 emissions from new cars by an average of 25% in the period from 1995 to 2008/2009 whilst 15% of the necessary effort towards the overall climate change target of the EU was met by this measure alone (DEHLG 2000).

Additional measures included in the National Climate Change Strategy (DEHLG 2006, 2007b) included: (1) VRT and Motor Tax rebalancing to favour the purchases of more fuel-efficient vehicles with lower CO_2 emissions; (2) continuing the Mineral Oils Tax Relief (MOTR) II Scheme and introduction of a biofuels obligation scheme; (3) implementation of a national efficient driving awareness campaign, to promote smooth and safe driving at lower engine revolutions; and (4) enhancing the existing mandatory vehicle labelling system to provide more information on CO_2 emission levels and on fuel economy.

10.6 Residual Impacts of the Proposed Road Scheme

The results of the air dispersion modelling study show that the residual impacts of the Proposed Road Scheme on air quality and climate will be insignificant.

10.7 Interaction and Inter-relationships with other Environmental Effects

Impacts on Air Quality and Climate will interact and/or interrelate with:

- Traffic: Traffic flows along the proposed Scheme interrelate with the air quality of the surrounding landscape. The free flow of traffic is important in order to minimise the generation of traffic emissions. Traffic is dealt with in Chapter 5.
- Human Beings: Exposure to windblown dust, other particulates and emissions of pollutants from road traffic is an important consideration for human health and a pleasant living environment.

However, no adverse impacts are predicted. Impacts on human beings are described in Chapter 6.

10.8 Monitoring

No monitoring is required.

10.9 Reinstatement

Not applicable.

10.10 Difficulties Encountered while Compiling this Information

No difficulties were encountered.

11.0 NOISE AND VIBRATION

11.1 Introduction

This chapter of the EIS assesses the impacts of noise and vibration associated with the proposed Northern Ring Rod Extension, Kilkenny. The scheme involves an extension of the Kilkenny Ring Road from the existing tie in roundabout along the Castlecomer Road to a tie in point along the Freshford Road.

11.2 Methodology

In order to assess the noise impact of any proposed road scheme, the following methodology is normally adopted.

The first stage is to assess and quantify the existing noise environment in the vicinity of sensitive receptors that may be affected by the proposed development. In the case of a road scheme, the selected noise-sensitive locations are likely to be those in closest proximity to the proposed road.

The noise levels resulting from both the construction and operational phases are then calculated using established prediction techniques. The noise levels associated with the operational phase of the proposed development are predicted in accordance with guidance set out in Calculation of Road Traffic Noise (CRTN), giving results in the form of $L_{A10(18hour)}$ values. These are then converted to L_{den} values in accordance with the procedures detailed in the NRA guidance. The derived values for L_{den} should be rounded to the nearest whole number, with 0.5 being rounded up.

The results of the predicted assessment are compared against the most appropriate criteria for both construction and operational phases. Where predicted noise levels are in excess of the adopted criteria, mitigation measures are proposed.

Further details of each phase of the assessment are set out in the individual sections of the chapter.

11.2.1 Assessment Criteria

Operational Phase

There are no statutory guidelines or standards for noise mitigation in Ireland applicable for Road Schemes. For new roads in Ireland, it is standard practice to adopt the traffic noise design goal contained within the NRA document *Guidelines for the Treatment of Noise and Vibration in National Road Schemes 2004*. This document specifies that it is considered appropriate to set the design goal for Ireland as day-evening-night 60dB L_{den} (free field residential façade criterion).

This criterion applies to new national roads and set the following criteria with respect to determining when mitigation measures are deemed necessary. The following three conditions must be satisfied under the NRA guidelines in order for noise mitigation to be provided:

- the combined expected maximum traffic noise level, i.e. the relevant noise level, from the proposed road scheme together with other traffic in the vicinity is greater than the design goal of 60dB L_{den};
- the relevant noise level is at least 1dB more than the expected traffic noise level without the proposed road scheme in place, and;
- the contribution to the increase in the relevant noise level from the proposed road scheme is at least 1dB.

These conditions will ensure that mitigation measures arising out of this process are based upon the degree of impact of the scheme under consideration. It should be noted that the Design Goal is applicable to new road schemes only. In addition, the design goal is applied to existing receptors in respect of both the year of opening and the design year, typically 15 years after projected year of opening.

The NRA guidelines acknowledge that it not always be possible to achieve the adopted design goal. In such circumstances, nevertheless, a structured approach should be taken in order to ameliorate as far as practicable road traffic noise through the consideration of measures such as alignment changes, barrier type (e.g. earth mounds) or low noise road surfaces.

11.2.2 Construction Phase

The NRA guidance document specifies noise levels that it typically deems acceptable in terms of construction noise. These limits are set out in Table 11.1.

Table 11.1 – Maximum Permissible Noise Levels at the Façade of Nearby Dwellings during Construction

Days & Times	$L_{Aeq\ (1hr)}$ dB	L_{Amax} dB(A)
Monday to Friday 07:00 to 19:00hrs	70	80
Monday to Friday 19:00 to 22:00hrs	60	65
Saturday 08:00 to 16:30hrs	65	75
Sundays and Bank Holidays 08:00 to 16:30hrs	60	65

It should be noted that the noise criteria quoted in the table above are specific to construction activities only (i.e. these levels are not cumulative with the existing noise environment from road traffic and other surrounding sources).

11.3 Description of Existing Conditions

A series of environmental noise surveys were conducted at locations along the length of the proposed link road. These locations have been chosen in order to quantify the existing noise environment in the vicinity of the noise-sensitive locations that may be affected by the proposed works.

11.3.1 Survey Periods

An unattended noise survey was conducted at one location over the course of the following survey period:

- Location S01f: 16:00hrs on 14 February to 16:00hrs 15 February 2013;

Attended monitoring was conducted at six locations (S01a to S01e) on 15 February 2013 between 10:00 and 17:00 hours. One of the attended locations is the same as the unattended location.

11.3.2 Measurement Locations

The measurement location coordinates and location descriptions are presented in Table 11.2 and illustrated in Figure 11.1.

Table 11.2 – Baseline Noise Monitoring Locations

Survey Location	Survey Area	Coordinates	
		Easting	Northing
S01-a	Castlecomer Road - South of link road	250493	158506
S01-b	The avenue- Weirview estate	250353	158567
S01-c	Bleach Road - North of Link Road	249808	158884
S01-d	Freshford Road - South of Link Road	249847	158407
S01-e	Freshford Road - Roundabout at Link Road Junction	249052	158666
S01-f	Auteven Hospital	249340	158693

11.3.3 Instrumentation

The shortened measurements were performed using a Brüel & Kjær Type 2260 Sound Level Meter. The continuous measurements were performed using Brüel & Kjær Type 3592 Environmental Kits with Brüel & Kjær Type 2238 Sound Level Meter. Before and after the survey the measurement apparatus was check calibrated using a Brüel & Kjær Type 4231 Sound Level Calibrator.

Procedure

Unattended Noise Measurement

The unattended continuous survey was performed over a 24-hour period at location S01-f. Sample periods were 1-hour long and the results were saved to the instrument memory for later analysis. L_{den} values are derived directly from the measured data.

Attended Noise Measurements (Derived Value)

Shortened measurements were conducted at 6 survey locations surrounding the unattended 24 hour location. Surveys were conducted on a cyclical basis with sample periods of 15 minutes. The results were noted onto a Survey Record Sheet immediately following each sample, and were also saved to the instrument memory for later analysis where appropriate. Survey personnel noted all primary noise sources contributing to noise build-up. The survey work was conducted in accordance with the shortened measurement procedure as laid down in the NRA guidance document.

When surveying traffic noise, the acoustical parameters of interest are $L_{A10\ (1hour)}$ and $L_{A10\ (18hour)}$, expressed in terms of decibels (dB) relative to 2×10^{-5}Pa. The value of $L_{A10\ (1hour)}$ is the noise level exceeded for just 10% of the time over the period of one hour. $L_{A10\ (18hour)}$ is the arithmetic average of the values of $L_{A10\ (1hour)}$ for each of the one hour periods between 06:00 and 24:00hrs.
The shortened measurement procedure involves a method whereby $L_{A10\ (18hour)}$ values are obtained through a combination of measurement and calculation as follows:

- noise level measurements are undertaken at the chosen location over three consecutive hours between 10:00 and 17:00hrs;
- the duration of the sample period during each hour is selected to encompass sufficient traffic flows to ensure reliable results;
- the $L_{A10\ (18hour)}$ for the location is derived by subtracting 1dB from the arithmetic average of the three hourly sample values, i.e. $L_{A10(18hour)} = ((\Sigma L_{A10(1hour)}) / 3) – 1$ dB.
- The L_{den} for the location is then derived from the calculated $L_{A10(18hour)}$ value,
- i.e. $L_{den} = 0.86\ L_{A10(18hour)} + 9.86$ dB.

Weather

Weather conditions during all survey periods were dry and calm. Wind speeds were below 1m/s during all monitoring rounds. Temperatures were in the range 4 to 6˚C.

Results of Noise Surveys

Table 11.3 presents the results of the attended measured noise levels for each of the survey locations. Table A1 in Appendix M present the results of the unattended survey results at the 24 hour location.

The results of the survey have indicated that the main sources contributing to noise levels at the surveyed locations are local and distant road traffic noise. Additional sources including farm yard

activities and plant noise within the hospital ground also contributed to noise levels at individual locations. Highest noise levels were recorded at Location S01-e which was measured on the road edge of the R963 Road (Freshford Road).

Table 11.3 Baseline Noise Monitoring Results

Survey Location	Survey Time	Measured Noise Levels (dB re.2x10^{-5}Pa)			dB L_{den}		Notes
		L_{Aeq}	L_{A10}	L_{A90}	Derived (Short term)	Measured (long term)	
S01-a	11:00 - 11:15	51	54	46	56	n/a	Road traffic noise from N77 dominates
	12:44 - 12:59	51	54	45			
	13:00 - 13:15	53	56	45			Road traffic noise. Some local movements from council vehicles
S01-b	11:18 - 11:33	44	46	38	46	n/a	Distant road traffic noise. Dogs barking in distance, car idling in estate.
	12:24 - 12:39	39	42	33			Distant traffic, no local activity
	13:20 - 13:35	43	41	33			Distant traffic and occasional local activity
S01-c	11:43 - 11:58	59	46	38	51	n/a	Distant road traffic noise, distant farm machinery, very occasional local vehicle movements
	12:00 - 12:15	58	51	39			
	13:45 - 14:00	61	48	37			
S01-d	14:14 - 14:29	41	42	37	46	n/a	Distant road traffic noise
	15:50 - 16:05	39	41	36			
	16:05 - 16:20	48	45	37			Distant road traffic noise,1 local movement, people talking nearby.
S01-e	14:35 - 14:50	64	69	44	69	n/a	Road traffic noise from R693 dominates
	15:28 - 15:43	65	70	45			
	16:28 - 16:43	64	69	47			
S01-f	14:54 - 15:09	50	53	42	53	52	Distant road traffic noise and hospital plant noise dominates
	15:09 - 15:24	47	49	42			
	16:47 - 17:02	49	51	42			

11.4 Assessment of Operational Noise

Noise Model

A computer-based prediction model has been prepared in order to quantify the traffic noise level associated with the operational phase of the proposed road scheme. This section discusses the methodology behind the noise modelling process and presents the results of the modelling exercise.

Brüel & Kjær Type 7810 Predictor

Proprietary noise calculation software was used for the purposes of this impact assessment. The selected software, Brüel & Kjær Type 7810 *Predictor*, calculates traffic noise levels in accordance with CRTN and NRA guidance.

Brüel & Kjær Type 7810 *Predictor* is a proprietary noise calculation package for computing noise levels in the vicinity of noise sources. *Predictor* predicts noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of sound power or traffic flow and average velocity;
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces, and;
- the hardness of the ground between the source and receiver.

Prediction of Traffic Noise

Noise emissions during the operational phase of the project have been modelled using *Predictor* in accordance with CRTN and with the application of the relevant conversion factors as detailed in the NRA Guidance. The CRTN method of predicting noise from a road scheme consists of the following five elements:

- divide the road scheme into segments so that the variation of noise within this segment is small;
- calculate the basic noise level at a reference distance of 10 metres from the nearside carriageway edge for each segment;
- assess for each segment the noise level at the reception point taking into account distance attenuation and screening of the source line;
- correct the noise level at the reception point to take account of site layout features including reflections from buildings and facades, and the size of source segment, and;
- combine the contributions from all segments to give the predicted noise level at the receiver location for the whole road scheme.

Input to the Noise Model

The noise model was prepared using the following data:

- Ordnance Survey mapping, and 3D topographical data as supplied by Clifton Scannell Emerson Associates, and;
- traffic flows and speeds as supplied by the design team.

Hourly noise predictions were conducted based on these traffic figures in accordance with Method A of the NRA guidelines. The hourly predictions were carried out using the diurnal traffic profiles provided in Appendix 1 of the NRA guidelines.

Output of the Noise Model

Predictor calculates noise levels for a set of receiver locations specified by the user. The results include an overall level in dB L_{den}.

Choice of Receiver Locations

Free-field traffic noise levels have been predicted at a 21 properties in the vicinity of proposed and existing roads. The coordinates of all locations are provided in Table 11.4. These receiver locations (Noise Assessment Locations) are detailed in Figure 11.2.

Traffic Noise Predictions

Traffic noise predictions have been conducted for two operational years, the proposed year of opening (2019) and the design year (2034). A total of four scenarios have been considered as follows:

- Opening Year– Do Minimum (i.e. proposed upgrade does not take place);
- Opening Year – Do Something (i.e. ring road is extended);
- Design Year – Do Minimum;
- Design Year – Do Something.

The results of the traffic noise predictions are presented in Table 11.5. Making reference to Section 11.2 of this document, the noise mitigation measures are only required whenever all three of the conditions specified by the NRA are satisfied.

Table 11.4 – Noise Assessment Locations

Reference	Location	Co-ordinates	
		Easting	Northing
R1	Freshford Road South	249,155	158,517
R2a	Freshford Road South	249,233	158,514
R2b	Freshford Road South	249,243	158,532
R3	Freshford Road South	249,381	158,482
R4	Freshford Road South	249,275	158,426
R5	Autemen Hospital	249,351	158,657
R6	Autemen Hospital	249,396	158,674
R7	Autemen Hospital	249,443	158,657
R9	Freshford Road North	249,038	158,831
R10	Bleach Road	249,683	159,043
R11	Bleach Road	249,652	159,076
R12	Farm House	250,245	158,966
R13	Castlecomber Road North	250,519	159,078
R14	Freshford Road	249,808	158,512
R15	Freshford Road	249,903	158,495
R16	Weirview Hill	250,270	158,517
R17	Weir View -The avenue	250,351	158,557
R18	Weir View The court	250,384	158,591
R19a	Castlecomer Road South	250,457	158,511
R19b	Castlecomer Road South	250,465	158,500
R20	Castlecomer Road South	250,498	158,451
R21	Weir View - The Hall	250,421	158,589

Table 11.5 Predicted Noise Levels for Years 2019 and 2034 for "Do Minimum" and "Do Something" Scenarios

Receiver Location Reference	Opening Year 2019		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2034		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?
	Predicted Noise Level						Predicted Noise Level					
	Do Minimum	Do Something					Do Minimum	Do Something				
	L_{den} (dB)	L_{den} (dB)	(a)	(b)	(c)		L_{den} (dB)	L_{den} (dB)	(a)	(b)	(c)	
R1	63	64	Yes	Yes	No	No	64	67	Yes	Yes	No	No
R2a	66	67	Yes	Yes	No	No	67	70	Yes	Yes	No	No
R2b	58	60	No	Yes	No	No	59	63	Yes	Yes	No	No
R3	53	56	No	Yes	No	No	54	58	No	Yes	No	No
R4	66	68	Yes	Yes	No	No	68	70	Yes	Yes	No	No
R5	51	60	No	Yes	Yes	No	52	63	Yes	Yes	Yes	**Yes**
R6	51	60	No	Yes	Yes	No	52	64	Yes	Yes	Yes	**Yes**
R7	48	57	No	Yes	Yes	No	49	60	No	Yes	Yes	No
R8	64	64	Yes	No	No	No	65	66	Yes	Yes	No	No
R9	47	54	No	Yes	Yes	No	48	57	No	Yes	Yes	No
R10	46	53	No	Yes	Yes	No	47	56	No	Yes	Yes	No
R11	54	56	No	Yes	Yes	No	54	58	No	Yes	Yes	No
R12	70	70	Yes	No	No	No	71	70	Yes	No	No	No
R13	48	54	No	Yes	Yes	No	49	57	No	Yes	Yes	No
R14	49	55	No	Yes	Yes	No	50	57	No	Yes	Yes	No
R15	51	53	No	Yes	Yes	No	51	55	No	Yes	Yes	No
R16	48	53	No	Yes	Yes	No	49	55	No	Yes	Yes	No
R17	50	55	No	Yes	Yes	No	51	58	No	Yes	Yes	No
R18a	58	58	No	No	No	No	59	59	No	No	No	No
R18b	59	59	No	No	No	No	60	59	No	No	No	No
R19	64	63	Yes	No	No	No	64	64	Yes	No	No	No
R20	63	63	Yes	No	No	No	64	64	Yes	No	No	No
R21	57	61	Yes	Yes	Yes	**Yes**	57	63	Yes	Yes	Yes	**Yes**

On review of the results set out in Table 11.5, during the design year of 2032, there are three receiver locations where the three conditions for noise mitigation have been satisfied. Receiver locations R5 and R6 represent calculated facades at the Autemen Hospital whilst receiver location R21 represents the closest residential properties within the Weirview estate at "The Hall" development.

In this instance, noise mitigation measures need to be considered for these properties.

11.5 Mitigation Measures – Operational Phase

Options for the reduction in traffic noise levels can take the form of a low noise road surface (LNRS) [2], the use of barriers and or bunds or a combination of both. For the purpose of this assessment, the use of a low noise road surface has been assumed along the length of the extended scheme as an initial mitigation measure. On analysis of this scenario, the use of noise barriers are also required to further reduce noise levels to within the adopted noise design goal for the scheme.

Table 11.6 presents the required extent of noise barriers assuming a low noise road surface along the extended road scheme. The barrier locations are presented in Figure 11.03.

Table 11.6 – Extent of Noise Barriers Required

Receiver No.	Barrier Chainage	Side of Road	Barrier Height (m)	Location
R5 – R6	~ Ch 210 – Ch 340	South	1.5m	Top of cutting
R21	~ Ch 1,300 – Ch 1,440	South	2m	Edge of Road

11.6 Residual Impacts – Operational Phase

The residual noise levels during the operational phase have been calculated, taking into account the proposed mitigation measures outlined in Section 11.5.

[2] The low noise surface should achieve a minimum noise reduction of -2.5dB when compared to Hot Rolled Asphalt.

Table 11.7 - Residual Noise Levels with Mitigation

Receiver Location Reference	Opening Year 2019		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2034		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?
	Predicted Noise Level						Predicted Noise Level					
	Do Minimum	Do Something					Do Minimum	Do Something				
	L_{den} (dB)	L_{den} (dB)	(a)	(b)	(c)		L_{den} (dB)	L_{den} (dB)	(a)	(b)	(c)	
1	63	64	Yes	Yes	No	No	64	66	Yes	Yes	No	No
2a	66	67	Yes	Yes	No	No	67	70	Yes	Yes	No	No
2b	58	60	No	Yes	No	No	59	62	Yes	Yes	No	No
3	53	55	No	Yes	No	No	54	58	No	Yes	No	No
4	66	68	Yes	Yes	No	No	68	70	Yes	Yes	No	No
5	51	57	No	Yes	Yes	No	52	60	No	Yes	Yes	No
6	51	58	No	Yes	Yes	No	52	60	No	Yes	Yes	No
7	48	55	No	Yes	Yes	No	49	58	No	Yes	Yes	No
8	64	64	Yes	No	No	No	65	66	Yes	No	No	No
9	47	53	No	Yes	Yes	No	48	55	No	Yes	Yes	No
10	46	51	No	Yes	Yes	No	47	54	No	Yes	Yes	No
11	54	56	No	Yes	Yes	No	54	57	No	Yes	Yes	No
12	70	70	Yes	No	No	No	71	70	Yes	No	No	No
13	48	53	No	Yes	Yes	No	49	55	No	Yes	Yes	No
14	49	53	No	Yes	Yes	No	50	55	No	Yes	Yes	No
15	51	52	No	Yes	Yes	No	51	54	No	Yes	Yes	No
16	48	51	No	Yes	Yes	No	49	53	No	Yes	Yes	No
17	50	53	No	Yes	Yes	No	51	55	No	Yes	Yes	No
18a	58	57	No	No	No	No	59	58	No	No	No	No
18b	59	58	No	No	No	No	60	59	No	No	No	No
19	64	63	Yes	No	No	No	64	64	Yes	No	No	No
20	63	63	Yes	No	No	No	64	64	Yes	No	No	No
21	57	58	No	Yes	Yes	No	57	59	No	Yes	Yes	No

With the proposed mitigation in place residual noise levels at all residential properties are reduced below 60dB L_{den} or are below the do minimum noise levels, hence, the three conditions for noise mitigation are no longer satisfied.

11.7 Construction Phase

Impacts Assessment

As per NRA guidance noise levels associated with construction may be calculated in accordance with the methodology set out in BS5228: Part 1. This standard sets out sound power levels for plant items normally encountered on construction sites, which in turn enables the prediction of noise levels at selected locations. However, it is often not possible to conduct detailed prediction calculations for the construction phase of a project in support of the EIS. This is due to the fact that the programme for construction works has not been established in detail. Under such circumstances, best practice involves the consideration of appropriate mitigation measures. The NRA guidance document specifies noise levels that it typically deems acceptable in terms of construction noise. These limits are set out in Table 11.1.

A variety of items of plant will be in use during the construction upgrade works. These will include breakers, excavators, dump trucks, compressors and generators in addition to general road surfacing and levelling equipment. Due to the nature of the activities undertaken on a road construction site, there is potential for generation of high levels of noise at nearby noise sensitive properties.

Due to the fact that the construction programme is not progressed to a detail level at this stage of the programme, it is not possible to calculate specific noise emissions to the local environment from different phases of works. However, the following tables present calculations of indicative noise levels for typical noise sources associated with road construction.

BS5228:2009 *Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1 Noise* sets out typical noise levels for items of construction plant. Tables 11.8 to 11.10 set out assumed plant items during the key phases of construction with the associated source reference from BS5228 *Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1 Noise*. The closest properties to the existing road edge are at distances of approximately 50m. Construction noise calculations have been conducted at distances of 50 to 150m from the works for each phase, representing the nearest properties to the works.

The calculations assume that plant items are operating for 66% of the time and that all plant items associated with the individual phases are operating simultaneously and at the same distance for any one scenario. A screening correction of 5dB has been included in the calculations, to take account of screening provided by cuttings along the road alignment.

Table 11.8 – Indicative construction noise calculations during site preparation and excavation works.

Site Clearance & Preparation		Calculated $L_{Aeq,T}$ at distance from road (m)			
		50m	80m	100m	150m
Pneumatic breaker	(C.8.12)	53	49	47	44
Wheeled loader	(C2.26)	58	54	52	49
Tracked excavator (loading dump truck)	(C1.10)	64	60	58	55
Dozer	(C.2.10)	59	55	53	50
Dump Truck	(C2.30)	58	54	52	49
Combined L_{Aeq} from all works		67	63	61	57

Table 11.9 – Indicative construction noise calculations during excavation and fill works

Excavation and Fill Works		Calculated $L_{Aeq,T}$ at distance from road (m)			
		50m	80m	100m	150m
Tracked excavator (loading dump truck)	(C1.10)	64	60	58	55
Articulated dump truck (dumping rubble)	(C1.11)	59	55	53	50
Wheeled loader	(C2.26)	58	54	52	49
Dozer	(C.2.10)	59	55	53	50
Dump Truck Tipping fill	(C2.30)	58	54	52	49
Combined L_{Aeq} from all works		68	63	61	58

Table 11.10 – Indicative construction noise calculations during road works

Road Works		Calculated $L_{Aeq,T}$ at distance from road (m)			
		50m	80m	100m	150m
Tracked excavator	(C2.21)	50	45	44	41
Dump Truck	(C2.30)	58	49	52	49
vibration rollers	(C5.20)	54	42	48	45
Asphalt Paver & Tipping Lorry	(C.5.31)	56	36	50	47
Diesel Generator	(C4.76)	40	55	34	31
Road Rollers	(C5.19)	59	57	53	50
Combined L_{Aeq} from all works		71	70	70	70

The results of the assessment has indicated that at distances of beyond 50m from the works, the construction daytime noise limit of 70dB L_{Aeq} can typically be complied with for the scenarios assessed. Note that these calculations are indicative only and are used for the purposes of comparison only with the adopted criteria. Whist the calculations have demonstrated that works can be conducted within the adopted criteria, it is recommended that the various best practice working methods used to control noise and vibration are adopted by the contractor during all works.

Construction Noise Mitigation Measures

The contract documents will clearly specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of BS5228-1 2009. These measures will typically include:

- No plant used on site will be permitted to cause an ongoing public nuisance due to noise.
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen.
- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Table 11.1 using methods outlined in BS5228:2009 *Part 1.*

Working Hours

Normal working times will be 07:00 to 19:00hrs Monday to Saturday. Works other than the pumping out of excavations, security and emergency works will not be undertaken outside these working hours without the written permission of the Contracting Authority. This permission, if granted, can be withdrawn at any time should the working regulations be breached.

Works other than the pumping out of excavations, security and emergency works will not be undertaken at night and on Sundays without the written permission of the Contracting Authority.

Emergency Work

The emergency work referred to above may include the replacement of warning lights, signs and other safety items on public roads, the repair of damaged fences, repair of water supplies and other services which have been interrupted, repair to any damaged temporary works and all repairs associated with working on public roads.

Construction Phase Residual Noise Impact

The assessment has indicated that construction activities can operate within the adopted noise limits for daytime periods at the nearest properties to the works. Given the linear nature of the works, noise

emissions related to construction works will be of short term impact at any one area as the works progress along the length of the scheme. The application of the proposed noise limits and restricted hours of operation, along with implementation of appropriate noise control measures, will ensure that noise impact is kept to within acceptable standards.

11.8 Vibration

Description of Existing Environment

A survey of vibration along the proposed route corridor was not undertaken, as levels associated with existing roads would not be expected to be of a magnitude sufficient to cause disturbance to people or structural damage to property. Furthermore, vibration was not perceptible at any of the noise survey locations.

Potential Impacts – Operational Phase

As a vehicle travels along a road, vibration can be generated in the road and subsequently propagate towards nearby buildings. Such vibration is generated by the interaction of a vehicle's wheels and the road surface and by direct transmission through the air of energy waves. Some of these waves arise as a function of the size, shape and speed of the vehicle, and others from pressure fluctuations due to engine, exhaust and other noises generated by the vehicle.

It has been found that ground vibrations produced by road traffic are unlikely to cause perceptible structural vibration in properties located near to well-maintained and smooth road surfaces. Problems attributable to road traffic vibration can therefore be largely avoided by maintenance of the road surface. Given that the existing road scheme does not generate any significant vibration levels at present, vibration levels associated with the upgrade works are not expected to generate any perceptible vibration levels.

Potential Impacts – Construction Phase

The potential for vibration at neighbouring sensitive locations during construction is typically limited to excavation works, breaking operations and lorry movements on uneven road surfaces. The more significant of these is the vibration from excavation and breaking operations; the method of which will be selected and controlled to ensure there is no likelihood of structural or even cosmetic damage to existing neighbouring dwellings.

Mitigation Measures and Residual Impacts

The NRA Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities should not exceed the values set out in Table 11.11.

Table 11.11 – Maximum Allowable Vibration Levels During Construction Phase

Allowable vibration velocity (Peak Particle Velocity) at the closest part of any sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	**10 to 50Hz**	**50 to 100Hz (and above)**
8 mm/s	12.5 mm/s	20 mm/s

Ground vibration from the operation of an additional traffic lane will be orders of magnitude less than that required to cause cosmetic or structural damage to buildings or lead to disturbance of occupiers, hence mitigation measures are not required in respect of the operational phase.

It may be concluded that the proposed road scheme is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or even cosmetic damage.

11.9 Interaction and Inter-relationships with other Environmental Effects

Impacts on Noise and Vibration will interact and/or interrelate with:

- Human Beings: The impacts of noise and vibration on human beings during the construction phase will be addressed through the implementation of a comprehensive EOP. The potential impacts of noise on human beings is addressed in Section 11.5 above.
- Cultural Heritage: The mitigation measures described under Section 11.8 above address the prevention of vibration impacts on cultural heritage.

11.10 Monitoring

No monitoring is required.

11.11 Reinstatement

Not applicable.

11.12 Difficulties Encountered while Compiling this Information

No difficulties were encountered.

12.0 LANDSCAPE AND VISUAL

12.1 Introduction

This chapter of the EIS provides an assessment of the landscape and visual impacts arising as a result of the proposed Scheme.

12.2 Assessment Methodology

The landscape and visual impact is assessed with regard to the sensitivity of the landscape and its vulnerability to change, taking consideration of the location of landscape and visual receptors relative to the proposed Scheme.

The methodology has regard to the following:

- EPA: Advice Notes on Current Practice in the preparation of Environmental Impact Statements (2003).
- EPA: Guidelines on Information to be Contained in Environmental Impact Statements (2002).
- Landscape Institute/Institute of Environmental Management & Assessment: Guidelines for Landscape and Visual Impact Assessment (2002).

The assessment involved reviewing the alignment and design of the proposed Scheme as it evolved, together with a review of proposals for the proposed River Nore bridge. Site visits were undertaken to further ascertain he physical and visual nature of the site, and to review the location and visual context of visual receptors.

12.2.1 Landscape

Landscape has two separate but closely related aspects. The first is visual impact, i.e. the extent to which a new development can be seen in the landscape. The second is impact on landscape character, i.e. impact on reposes that are felt towards the landscape, drawing on the appearance of the land including shape, form and colour, and the interaction of these elements to create specific patterns that are distinctive to particular localities.

Visual Impact

Visual impacts are defined under visual and/or visual obstruction where:

- Visual intrusion involves impact on a view, but avoiding blocking the view.
- Visual obstruction involves impact on a view with at least some degree of blocking.

Landscape Character Impact

The character of the existing landscape setting is evaluated taking account of the various natural and man-made features, such as topography, landform, land-use, vegetation, built environment etc.,

together with the visibility of and the views to and from the landscape. In addition aspects relating to the landscape planning environment are considered on a national, regional and local basis.

12.2.2 Significance Assessment Criteria

The significance criteria used for the landscape and visual impact assessment are based on those given in the EPA Guidelines on the Information to be contained in Environmental Impact Statements, 2002 as set out, with explanatory characteristics in Table 12.1.

Table 12.1 – Significance Criteria

Impact Level	EPA Definition	Characteristics
Imperceptible	An impact capable of measurement but without noticeable consequences.	Proposals are barely appreciated or discernible with little or no effect on the scene.
Slight	An impact, which causes noticeable changes in the character of the environment without affecting its sensitivities.	Proposals comprise a minor component of the wider view without a marked effect on the overall quality of the scene.
Moderate	An impact that alters the character of the environment in a manner that is consistent with the existing and emerging trends.	Proposals form a visible ad recognisable new element with the overall scene and will be readily noticed by the observer.
Significant	An impact, which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.	Proposals become the dominant feature of the scene so that other existing elements are reduced in significance.
Profound	An impact, which completely removes sensitive characteristics.	Proposals permanently alter an existing scene and reduces its existing quality.

The impact of the proposed Scheme was assessed at two stages:

- Construction Stage: impact arising during the period of initial site setup works up to the opening of the proposed Scheme to normal operation.
- Operation Stage: impact arising during the period of normal operation of the altered Scheme.

Duration of impact, which may be negative, neutral or positive, is considered as being either:

- Temporary (lasting 1 year or less).
- Short Term (last 1 to 7 years).
- Medium Tern (lasting 7 to 15 years).

- Long Term (lasting 15 to 60 years).
- Permanent (lasting in excess of 60 years).

12.3 The Existing Environment

12.3.1 Context

The proposed Scheme runs from the Freshford Road through agricultural land to the River Nore, crosses the River Nore with a bridge, and continues through agricultural land that is subject to severe flooding to the Bleach Road. The Bleach Road will form a t-junction with the proposed road on the north side of the Scheme. From this access road to the proposed Scheme there will be a t-junction with a road that will run in an underpass under the proposed road, joining with the existing Bleach Road to the south side of the Scheme. From the Bleach Road, the proposed Scheme runs through agricultural land as far as the Castlecomer Road.

12.3.2 Landscape Planning

National Level

No area in the vicinity of the proposed Scheme is identified in the 'Inventory of Outstanding Landscapes in Ireland', prepared by An Foras Forbartha in 1977.

County and City Level

Planning and Development is guided by the policies and objectives as set out in the Kilkenny County Development Plan 2008-2014, and more specifically in the Kilkenny City and Environs Development Plan 2008-2014.

Subject Development

The Scheme is shown as a line on the zoning map of the Kilkenny City and Environs Development Plan 2008-2014.

County Kilkenny Rural Landscape

Kilkenny's rural landscape is mostly used for agricultural purposes. The proposed Scheme runs through an cSAC, an SPA and a pNHA. The Scheme has been designed to minimise the impact on these protected areas as much as possible.

Architectural Heritage and Architectural Conservation Areas

Issues relating to architectural heritage and protected structures are discussed in detail elsewhere in this EIS. There are no Architectural Conservation Areas within the landtake of the proposed Scheme.

River Nore

Section 6.1.4 of the Kilkenny City and Environs Development Plan 2008-2014 states that the Councils will seek to ensure that proposals along the River Nore will achieve an appropriate balance of uses

commensurate with the sensitivity of the natural environment and goes on to set out protection and access policies for the River Nore:

- RTA12 Protect and improve the natural amenity potential and accessibility of the River Nore.
- RTA13 Protect and improve access to the River Nore without compromising the quality and setting of the river.

Views and Prospects

Section 7.3 and Figure 7.1 of the Kilkenny City and Environs Development Plan 2008-2014 list 13 Views and Prospects. The proposed Scheme does not fall directly within the context of any of the listings.

Tree Protection

There are no Tree Protection Orders (TPOs) within the context of the proposed Scheme. A tree survey will be carried out prior to commencement of construction work, and any relevant trees will be given due consideration.

12.3.3 Summary and Significance

The line of the proposed Scheme is not particularly sensitive or significant in terms of landscape and visual impacts. Nevertheless, it does have potential for impact on some sensitive areas, including the River Nore cSAC.

12.4 Potential Impacts of the Scheme

12.4.1 Introduction and Outline Description

The Scheme is designed as a standard single carriageway which will incorporate features appropriate to a rural or ring road setting.

12.4.2 Landscape and Visual Impact: Construction Stage

The general disturbance associated with construction works, such as tree and boundary removal, soil stripping, construction activity etc. will have a landscape and visual impact along the length of the proposed Scheme. Construction impacts are generally temporary or short-term in duration, lasting up until the opening of the Scheme. However, the impacts of the proposed works are sometimes medium or long-term or permanent, and such impacts are discussed separately under operation stage impacts.

Proposed Scheme from Freshford Road to proposed River Nore Bridge (Ch. 00 to 390)

The proposed Scheme will remove field boundaries between the Freshford Road and the River Nore bridge. The works will leave a strip of severed land between the Scheme and the boundary of Auteven Hospital.

Proposed River Nore Bridge (Ch. 390 to 440)

The construction of the proposed River Nore bridge will be amongst the most openly visible and prominent feature of the overall Scheme. Works to the bridge will cause the disruption of an area of cSAC, and will necessitate the removal of several mature trees.

Proposed River Nore Bridge to Bleach Road (Ch. 440 to 800)

The proposed Scheme will remove field boundaries between the bridge and the Bleach Road. The road will be on a significant embankment which will make is a visible and prominent feature in the surrounding countryside.

Proposed Bleach Road to Castlecomer Road (Ch. 800 to 1450)

The proposed Scheme will remove field boundaries between the Bleach Road and the Castlecomer Road. The road construction will impact on the cSAC. The road will be on a significant embankment which will make a visible and prominent feature in the surrounding countryside.

12.4.3 Landscape and Visual Impact: Operation Stage

The proposed Scheme will significantly impact on the landscape of the area that it traverses. The proposed Scheme is for the most part elevated significantly above the level of the surrounding countryside. The large 2:1 embankments that the Scheme requires will allow for extensive planting and habitat creation, however, between the river and the Bleach Road the embankments will be significantly steeper than 2:1 which will not allow for any planting.

The proposed bridge, though of understated design, will be a significant visual structure, sitting prominently in view from the Freshford Road and Bleach Road. Most of the road itself, on significant embankment, will also be a significant visual structure. Initially, the significance of the scale of change will result in a significant negative impact. However, in the short to medium-term the proposed bridge and embankment will become a well-utilised and appreciated element of the established fabric of the City and County.

The operational phase will give rise to potential impacts not only from the visual presence of the Scheme but also from the changes in traffic movements, illumination etc. Impacts will be greatest in the short-term after opening when the Scheme will be an unfamiliar visual element within the otherwise established rural landscape. In time it will become part of the established character.

12.5 Mitigation Measures

12.5.1 Introduction

The mitigation of visual impact is an inherent feature of the design and layout of the proposed Scheme as follows:

- The proposed River Nore bridge has been purposely designed as an understated and uncomplicated structure so as to reduce its intrusiveness.
- Appropriate planting will be provided on all 2:1 slope embankments.

Construction Phase Mitigation Measures

- The area to be taken for the construction of the proposed Scheme shall be the minimum necessary.
- Except where road or entrances dictate otherwise, a solid hoarding, a minimum 2.0m high, shall be erected along the construction site boundary.
- Trees will be removed only where necessary. A site specific tree survey will be carried out in advance of detailed construction procedures and will include appropriate work method statements and tree retention and protection proposals. The pre-construction tree survey will be repeated at the end of the construction works and any necessary remedial tree-works to ensure the safe retention of the trees will be completed by the end of the works.
- Trees to be retained will be adequately protected, and where possible will be protected in line with the provisions of BS 5837 Trees in Relation to Construction.
- Construction traffic shall avoid using the Bleach Road.
- Access will be maintained to all lands adjacent to the Scheme.
- Site lighting will be the minimum required for the safe operation of the works. Such lighting shall be directed towards the works and horizontal cut-off light fittings will be used to prevent light spill outside of the site.
- Site compounds will avoid impacting on areas outside of the road construction area.

In addition to the above, good working practices shall be established through the implementation of the EOP as part of the implementation of the mitigation strategy.

Operational Phase Mitigation Measures

Mitigation measures are set out on a section by section basis within Table 12.2 below. General operational phase mitigation measures include:

- Light fittings appropriate to a ring road will be used along the Scheme. The River Nore bridge will be lit by lower level lighting fixtures and illumination of the proposed bridge will be discrete. Horizontal cut-off light fittings will be used to retain light spill to the Scheme corridor.
- Where private gateways, boundaries or walls are disturbed or removed, the same or similar will be re-constructed at the line of the proposed land-take or elsewhere in agreement with the land owner, if appropriate.
- Appropriate planting will mitigate against loss of habitat and lost field boundaries and trees.

12.6 Residual Impacts

The proposed Scheme will be a permanent part of the infrastructure of Kilkenny City and County and, as such, will have residual impacts on its setting. Direct landscape and visual impacts will reduce with gradual establishment and with familiarity and use. While the proposed River Nore bridge will remain as a significant and prominent visual structure; its minimally intrusive design is considered appropriate within the context of the rural setting.

The proposed Scheme will also have indirect impacts on the future development of the City changing existing traffic movements. These indirect effects will include the positive impact of reducing congestion within the City Centre. This will allow for an improvement in the urban streetscape and visual environment of the commercial and tourist heart of the City.

12.7 Interaction and Inter-relationship with other Environmental Effects

Impacts on Landscape and Visual Aspects will interact and/or interrelate with:

- Flora and Fauna: In the assessment of impact on landscape and visual aspects, cognisance has been given of the likely mitigation measures required for flora and fauna, and all proposed planting.
- Cultural Heritage: The landscape of the study area contains a number of archaeological and architectural features. More details are contained in Chapter 13 Archaeology, Architecture and Cultural Heritage.

Table 12.2 – Landscape Mitigation Measures

Reference	Chainage	Proposed Mitigation: Specific Mitigation
Zone 1	Freshford Road Roundabout	The embankments on all sides of the roundabout will be planted appropriately.
Zone 2	Freshford Road Roundabout to the River Nore Bridge	The embankments will be planted appropriately.
Zone 3	Vicinity of the River Nore Bridge	The banks of the River Nore will be reinstated appropriately following the works.
Zone 4	River Nore Floodplain	The reinforced earth embankments along the River Nore floodplain will be too steep for growth.
Zone 5	Bleach Road to Castlecomer Road	The embankments will be planted appropriately.
Zone 6	Castlecomer Road Roundabout	The embankments on all sides of the roundabout will be planted appropriately.

12.8 Monitoring

Good working practices will be established and monitored as per the EOP and these will be prepared for the proposed Scheme in advance of the construction phase so as to reduce any negative impacts on landscape and visual aspects arising from construction. Landscape reinstatement works will require appropriate inspection and monitoring.

12.9 Reinstatement

Reinstatement proposals as set out under Section 12.5 Mitigation Measures.

12.10 Difficulties Encountered in Compiling this Information

No difficulties were encountered.

13.0 ARCHAEOLOGY, ARCHITECTURE AND CULTURAL HERITAGE

13.1 Introduction

13.1.1 General

This report outlines the archaeological heritage, architectural heritage and cultural heritage issues in respect of the lands proposed for the route of the Kilkenny Northern Ring Road Extension, Kilkenny, County Kilkenny. The purpose of the archaeological, architectural and cultural heritage section of the environmental impact statement (EIS) is to assess the importance and sensitivity of the receiving archaeological and historical environment, to identify the impact of the proposed route on this environment and to propose measures to ameliorate any perceived impacts. The report has provided sufficient cultural heritage data to advise of the likely significant impacts and to advise on mitigation measures taken to avoid, reduce and where possible remedy significant adverse impacts (if applicable).

13.1.2 Details of Proposed Route

The proposed route will connect the N77 Castlecomer Road with the R693 Freshford Road, travelling for the most part through Loughmerans townland, crossing the River Nore and finishing in Dunmore townland. This route was selected from nine route options and a brief overview of the proposed routes is summarised here and presented in a comparison matrix below (Table 13.1; Figure 13.6).

All of the proposed route options impact on areas of archaeological potential and on an item of built heritage interest. As there is no discernible or appreciable difference in the potential impacts of route options 4, 5, 7, 8 and 9 (the proposed route under investigation in this report) on the archaeological, architectural or cultural heritage, any of these four route options could be the preferred choice from an archaeological, architectural or cultural heritage perspective. Both route options 3 and 6 would have no direct or indirect impacts on the recorded archaeological or architectural heritage, but both would impact an additional item of built heritage interest and as such, are considered less preferable. Route options 1 and 2 have an indirect and direct impact respectively on a recorded archaeological enclosure site and consequently are the least preferred of the nine options.

Table 13.1 – Route Option Comparison Matrix

Route Option No.	RMP	Area of Archaeological Potential	RPS/NIAH	Items of Built Heritage Interest	Preference
1	Potential impact on RMP enclosure site KK014-065, located c.10m south of route	Potential impact - river crossing - greenfield - crosses Dunmore/ Loughmerans townland boundary	No impact	Direct impact on railway embankment of former GSW Railway	**3rd**
2	Direct impact on RMP enclosure site KK014-065	Potential impact - river crossing - greenfield - crosses Dunmore/ Loughmerans townland boundary	No impact	Direct impact - on former Richmond Demesne - on railway embankment of former GSW Railway	**4th**
3	No impact	Potential impact - river crossing - greenfield - crosses Dunmore/ Loughmerans townland boundary	No impact	Direct impact - on former Richmond Demesne - on railway embankment of former GSW Railway	**2nd**
4	No impact	Potential impact - river crossing - greenfield - crosses Dunmore/ Loughmerans townland boundary	No impact	Direct impact on railway embankment of former GSW Railway	**1st**
5	No impact	Potential impact - river crossing - greenfield - crosses Dunmore/ Loughmerans townland boundary	No impact	Direct impact on railway embankment of former GSW Railway	**1st**
6	No impact	Potential impact - river crossing - greenfield - crosses Dunmore/ Loughmerans townland boundary	No impact	Direct impact - on former Richmond Demesne - on railway embankment of former GSW Railway	**2nd**

Route Option No.	RMP	Area of Archaeological Potential	RPS/NIAH	Items of Built Heritage Interest	Preference
7	No impact	Potential impact - river crossing - greenfield - crosses Dunmore/ Loughmerans townland boundary	No impact	Direct impact on railway embankment of former GSW Railway	**1st**
8	No impact	Potential impact - river crossing - greenfield - crosses Dunmore/ Loughmerans townland boundary	No impact	Direct impact on railway embankment of former GSW Railway	**1st**
9	No impact	Potential impact - river crossing - greenfield - crosses Dunmore/ Loughmerans townland boundary	No impact	Direct impact on railway embankment of former GSW Railway	**1st**

13.1.3Topography

The topography of the landscape through which the proposed route passes is predominantly undulating, good pasture land with the River Nore winding its way roughly south/southeastwards through the landscape.

13.2 Environmental Impact Assessment Methodology

Sources

- Record of Monuments and Places (RMP) and Sites and Monuments Record (SMR);
- Record of Protected Structures (RPS);
- The topographical files of the National Museum of Ireland;
- Documentary and cartographic sources;
- Excavations Bulletins and Excavations Database (1970-2009);
- Kilkenny County Development Plan 2008–2014;
- National Inventory of Architectural Heritage (NIAH), Survey of the Architectural Heritage of Kilkenny (2005);
- NIAH, Surveys of Historic Gardens and Designed Landscapes, Kilkenny (2003-5);
- Heritage Audit of the Northern River Nore (Kilkenny County Council, 2009);
- Irish Architectural Archive;
- Aerial photographs.

Surveys

- Field inspection.
- Geophysical survey.

Full details of the above sources are contained in Appendix N.

Consultation

- Consultation was carried out with the design team; the National Monuments Section of the Department of Arts, Heritage and the Gaeltacht, the Heritage Officer and Conservation Officer of Kilkenny County Council.

13.3 Legislation, Standards, Guidelines

The following legislation, standards and guidelines were consulted:

- National Monuments Acts, 1930-2004;
- The Planning and Development (Strategic Infrastructure) Act, 2000-2010
- Heritage Act, 1995;
- European Convention Concerning the Protection of the Archaeological Heritage of Europe, ‘Valetta Convention’ (ratified by Ireland in 1992);

- Council of Europe Convention of the Protection of the Archaeological Heritage of Europe, 'Granada Convention' (ratified by Ireland in 1997);
- Guidelines on the information to be contained in Environmental Impact Statements, 2002, EPA;
- Advice Notes on Current Practice (in preparation of Environmental Impact Statements), 2003, EPA;
- Frameworks and Principles for the Protection of the Archaeological Heritage, 1999, (formerly) Department of Arts, Heritage, Gaeltacht and Islands;
- Architectural Heritage (National Inventory) and Historic Monuments (Miscellaneous Provisions) Act, 2000 and the Local Government (Planning and Development) Act 2000;
- Code of Practice between the National Roads Authority (NRA) and the Minister for Arts, Heritage and the Gaeltacht, June 2000 ;
- Guidelines for the Assessment of Architectural Heritage Impact of National Road Schemes, 2006, NRA;
- Guidelines for the Assessment of Archaeological Heritage Impact of National Road Schemes, 2006, NRA; and
- Guidelines for the Testing and Mitigation of the Wetland Archaeological Heritage for National Road Schemes, 2006, NRA

Excerpts from the relevant legislation and details regarding standards and guidelines are contained in Appendix N.

13.4 Significance Criteria

13.4.1 Archaeological and Cultural Heritage

In accordance with the NRA 'Guidelines for the Assessment of Archaeological Heritage Impact of National Road Schemes' (2006), the significance criteria used to evaluate an archaeological site, monument or complex are as follows: existing status (level of protection), condition or preservation, documentation or historical significance, group value, rarity, visibility in the landscape, fragility or vulnerability, and amenity value (Cf. Appendix N).

In accordance with EPA guidelines, the context, character, significance and sensitivity / vulnerability of each site, monument or complex is assessed (Cf. Appendix N). Any impact on a recorded archaeological monument or site is regarded as a significant negative impact. A glossary of impacts as defined by the EPA is provided in Appendix N.

13.4.2 Architectural Heritage

The report seeks to identify the properties/structures of architectural heritage merit that will be impacted by the proposed scheme. The mitigation recommendations made in respect of the structures or buildings identified relate to those that are directly impacted only; buildings impacted owing to their

proximity to the proposals are dealt with in the Landscape and Visual Assessment chapter of the EIS, which deals with screening. Recommendations are based on the architectural heritage merit of a structure or building, and whether this necessitates its preservation, either by avoidance, or by record.

A number of categories of special interest are taken into consideration when assessing the significance of a property/structure. These include architectural, historical, archaeological, artistic, cultural, scientific, technical or social.

13.5 Description of Existing Environment - *Archaeological Heritage*

13.5.1 Archaeological and Historical Background

Prehistoric Period

Throughout the prehistoric period, rivers provided the primary access route for moving through the landscape as well as an exploitable environment for human activity and settlement. The River Nore, which cuts through the study area, would have been the focus of such activities and artefacts recovered during the Nore flood-relief scheme (albeit outside of the study area) support this. A small quantity of Mesolithic flint was found in the excavated river-gravels in Kilkenny City (Bennett 2002:1024), providing evidence from the period of earliest human activity in Ireland (c.8000-4000BC). Mesolithic groups of transitory hunter-gatherers predominantly exploited the fertile coastline but also exploited the internal river way system.

The Neolithic period (c.4000-2500BC) saw the gradual transition of these early transitory hunter/gatherers to a farming community with the introduction of cattle, sheep, and crops (wheat and barley predominantly) perhaps bolstered by a fresh influx of new populations. The result of the settlement community was land clearance and the establishment of field systems, along with permanent settlement sites, not only along the coast, but penetrating into the interior especially along river valleys. A series of polished-stone axes dating to the Neolithic was also recovered from the river, during the flood-relief scheme in the city; such axes were used in wood-working and to fell trees (Devine et al. Vol. I, p.10).

Although there is no known or recorded evidence for prehistoric activity in the immediate environs of the proposed route, excavations in advance of the N77 ring road extension from the Dublin Road to the Castlecomer Road in 2003 revealed a previously unknown Early Bronze Age funerary pit in Garrincreen townland (Bennett 2004:0878). Burial evidence appears to mark the northern Nore out as a place of major significance during the Bronze Age; over 100 burial sites are spread along its valley, of which 80 are located between Kilkenny city to the south and Ballyragget to the north, with cemeteries found along the river banks at Ballyconra, Parks Grove, Grange and Lismaine (Devine et al. Vol. I, p.13).

The dominant funerary rite which was used in the cemeteries was the placing of the body (usually cremated and accompanied by a pottery vessel) in a mound and/or cist which was then surrounded by a circular ditch and then a bank (known as 'ring-ditches'). Most of the examples that were found within the study area of the *Heritage Audit of the Northern River Nore* (2009) were plough-damaged; only their deepest parts – usually the surrounding ditch – remain intact and often only visible as crop-marks. In some instances, however, the burials were simply laid within so-called flat cemeteries, which are thought to have had no surface expression at all. Many of these sites were positioned overlooking the Nore, which strongly suggests that the river itself was significant in their placing and that perhaps the Nore was seen as somehow sacred (Devine et al. Vol. I, p.13).

The more practical significance of the river as a food source is also evident in the archaeological record for the general area around the proposed route. The earliest evidence for fishing on the Nore was found beneath John's bridge in the city, where archaeological excavations revealed the well-preserved remains of a wattle fish-trap (radiocarbon dated to the Late Bronze Age, 1200-800 BC; Devine et al. Vol. I, p.50).

Early Medieval Period

By the third century AD the pollen record shows a dramatic increase in agricultural activity in Ireland, which was caused by a massive increase in population. In north Kilkenny, as elsewhere, this is reflected in the widespread distribution of defended farmsteads, 'ringforts'. Many of these sites are in a classic topographical situation, on the slope of a defensible ridge on relatively good land overlooking the River Nore or its tributaries (Devine et al. Vol. I, p.14).

The majority of the recorded monuments located within and in the environs of the assessment area are enclosures, with one ringfort (KK019-006) and a crannóg (KK014-063), signifying a relatively dense distribution of early medieval settlement activity in this area (c. AD400–1150). Ringforts are by far the most common archaeological monuments in the country. They are characterised as a circular area defined by banks and external ditches and excavation often reveals the remains of dwelling houses within their interior. The banks are generally constructed of earth except in stony areas where they may be of stone. Those with earthen banks are sometimes referred to as 'raths' while those with stone banks are known as 'cashels'. Most ringforts are enclosed by a single bank (a 'univallate' ringfort) but it is also quite common for them to have two sets of banks ('bivallate') or even three ('trivallate'). Ringforts are usually situated on gentle slopes with good views of the surrounding countryside and although they tend to have a dispersed distribution in the landscape, they are occasionally found in pairs.

Another common feature of the early medieval landscape is the crannóg, an artificial or natural island used for settlement during this and earlier prehistoric periods. A crannóg (KK014-063) is located in Loughmerans townland, in an area of bog to the north of the assessment area.

Monastic settlement in the area during this period may also be a possibility, given the richness of the soils in the catchment of the River Nore, a fact that was exploited later on by the medieval religious orders, such as the Cistercians at Jerpoint Abbey. Christianity had reached Kilkenny by the fourth century AD. Early Medieval churches tend to follow the rivers and this is no less the case in the environs of the northern River Nore, with churches sited at Grange Mochu, Anker's Island and Ardaloo. What is now the city of Kilkenny was an important ecclesiastical centre with perhaps as many as five early church-sites within a couple of miles of the centre. Cill Chainnigh (now St Canice's cathedral, Irishtown) had become the most important church in Leinster, outside Dublin, by the twelfth century a substantial 'monastic town' had grown up around it (Devine et al. Vol. I, p.16).

Similar to raths in morphology, monastic settlement sites were considerably larger, often up to 100m in diameter, with internal domestic and agricultural structures and, frequently, industrial and economic activity outside of the enclosure(s). They often contained a small church, of wood or stone, together with a cemetery. Raths or ringforts were sometimes re-used during the early medieval period to house churches or ecclesiastical settlements.

Five enclosures or enclosure sites are recorded in the general vicinity of the proposed route (KK014-064 & -065, KK019-008, -011 & -010), one of which lies c.60m north of the proposed route on a ridge of higher ground (KK014-065). The term 'enclosure' is applied to monuments that cannot be classified more accurately without archaeological assessment but that were identified as enclosures during fieldwork or through the study of aerial photography or other sources. When investigated further through archaeological assessment, enclosures often prove to be highly denuded ringforts, former church sites, or some other prehistoric archaeological site type. They can also prove to be of no archaeological significance, as is the case with the enclosure site KK019-010 (See below Section 1.5.4).

Medieval Period

Following the initial Anglo-Norman incursions in Ireland in the late twelfth century Richard 'Strongbow' de Clare was created Lord of Leinster by the King of England. As lord, Strongbow began to grant territory to his favourites in exchange for military service (knight service). These grants of land were expressed in terms of knights' fees, with payment due from each tenant-in-chief to their lord who was ultimately accountable to the King of England. The granting of lands, and knight's fees, continued under Strongbow's successor, the Earl Marshal, beginning in the 1190's and also through their descendants. The lands they held were those of the Irish who often lived alongside the new tenants, sometimes in opposition but at times in alliance with this Anglo-Norman landed gentry. Theobald Troye, is listed as one of the tenants paying knight's fees assigned in dower to Gilbert de Clare's widow in 1314/15, and was undoubtedly associated with the townland of Troyswood to the north of the proposed route.

There is clear evidence that the strong Anglo-Norman presence in Kilkenny City extended into the lands north of the city itself. Orpen refers to 'Locmadran' (1920, 93; presumably Loughmerans) and states that 'here in 1307 there were a bretage (a wooden fortification associated with a motte and bailey), grange, stable, sheepfold on posts, in bad condition and ruinous. The earthworks of the bretage, easily discernible, look from the neighbouring railway like a motte, but may be more properly classed as a promontory fort, fully forty feet high, jutting out into the dried up lake. It has a roughly triangular space, twenty-three paces by thirteen on top, cut off by a wide ditch from a rectangular bailey.' The author also makes a note in the text of having visited the site and identified the bretage (Orpen, 1920, 93). The influence of the medieval religious houses is also evident in this area, with townland names such as Coolgrange, Friarsinch and Bishopsfurze suggesting that much of this land was owned or farmed by the church.

During the medieval period, the River Nore was a vital trade artery that linked Kilkenny with its port at New Ross and was an important part of the city economy. Many mills were built during the period of Edward II's wars to feed his armies (1284-1327). There are also records of mills in the city prior to this, such as the Chancellor's mill, Castle mill (Ormonde mill) and Maudlin mill. The ownership of fishing weirs and rights was jealously guarded and there were many such weirs in the southern part of the Nore. The men who controlled the town until the Cromwellian occupation in 1650 were mainly wealthy wool-merchants whose fulling mills dotted the Nore and its tributaries. One of John Rothe FitzPiers' tuck mills, the builder of Rothe House in Kilkenny City, was situated near the Greenvale woollen mill (Devine et al. Vol. I, pp.24-5). The site of the Greenvale woollen mill (Bleach Mills as depicted on the first edition OS map of 1839) is located c. 460m south of the proposed route. Another important mill was located at Dunmore, c.850m to the north, and the road connecting the two (Bleach Road) crosses the proposed route. The 'Dunmore Woollen Manufactory' is also depicted on the first edition OS map but was known to have been constructed on the site of an earlier mill.

Post-Medieval Period

Milling continued to be a significant feature along the river in the post-medieval period (c.17th–19th centuries), the mid-eighteenth to nineteenth century saw the construction of large mill buildings, breweries, distilleries and woollen factories along the River Nore. It was the harnessing of Kilkenny's rivers that powered virtually all these industries and in the county as a whole in the first half of the nineteenth century, there were 72 corn mills, 44 flour mills and 11 tuck mills (for cleansing and preparing cloth) (Devine et al. Vol. I, p.30). As a result of the narrow river channel on the northern Nore and the lack of water volume in comparison to the south, milling was problematical and required major investments in infrastructure. Thus the mill-races tend to be extremely long, in some cases over 2km, to facilitate a large-enough head of water to power the mill-wheel effectively. Thirteen mills have been recorded on the northern River Nore, although most of these mill-buildings outside the city have been lost (including those at Dunmore) many of their weirs and mill-races still survive relatively intact (Devine et al. Vol. I, p.30).

13.5.2 Recorded Archaeological Sites within or in the vicinity of the proposed route

There are no recorded archaeological sites located along the proposed route of the ring road extension (Figure 13.01). A recorded enclosure site (KK014-065) is located c.65m north of the proposed route in Loughmerans townland.

A second enclosure site (KK014-065) is located c.235m to the northwest of this site (KK014-065). Two further enclosure sites, a ringfort and a crannóg are recorded within the wider area (KK019-011,-008,-006 & KK014-063). These are discussed in the context of the archaeological and historical background above (Section 4.1; Figure 13.1). Descriptions of the individual sites are contained in Appendix N.

While an additional recorded archaeological site, KK019-010, is shown on the RMP map (Figure 13.1), this was investigated during archaeological testing in advance of the construction of a section of the ring road on the east side of the N77 road and was found to be non-archaeological in nature.

13.5.3 Topographical Files, Museum of Archaeology & History, NMI

A search of the topographical files yielded no record of stray finds from the townlands of Baun, Dunmore, Loughmerans, Talbotsinch, Troyswood, Glendine, Raheenagun and Coolgrange.

13.5.4 Previous Archaeological Investigations

A search of the Excavations Bulletins and of the associated database (www.excavations.ie, 1970-2009) yielded no results for the townlands of Dunmore, Loughmerans or the surrounding townlands of Talbotsinch, Troyswood, Oldpark, Raheenagun and Coolgrange.

Centre-line testing was carried out in advance of the N77 ring road extension from the Dublin Road to the Castlecomer Road in 2003, along the proposed route of the extension in Baun, Bonnetsrath, Neworchard, Garrincreen, Blanchfieldsland and Leggetsrath West townlands (Licence No. 03E1719). The testing identified two previously unknown archaeological sites which were subsequently excavated: a bi-vallate ringfort situated on a small gravel hillock in Blanchfieldsland (Licence No. 04661; Bennett 2004:0868) and an Early Bronze Age (EBA) funerary pit in Garrincreen (Licence No. 04659; Bennett 2004:0878). Down-slope from the ringfort site was a deep accumulation of hill-wash that afforded protection to many of the features associated with peripheral activity at the site, including two corn-drying kilns, a scatter of post-holes, stake-holes, pits and a complex of linear field boundaries.

The programme of testing also identified further activity in the area, recording a number of apparently isolated features (hearths and pits) within Bonnetsrath, Neworchard and Garrincreen townlands. The two pits in Garrincreen were located close to the Early Bronze Age funerary pit and contained a

combined weight of 70g in charred seed remains, as well as charcoal and hazelnut fragments and a possible saddle quern fragment (Bennett 2003:1018).

Site specific archaeological testing was undertaken in Baun townland at the site of an enclosure listed in the RMP (KK019-010) in advance of the N77 ring road extension from the Dublin Road to the Castlecomer Road (Licence No. 03E1720). A total of fifteen test-trenches were excavated at the site. No evidence of an enclosure was revealed in any of the trenches and the site was deemed to be of no archaeological significance (Bennett 2003, 984).

13.5.5 Cartographic Evidence

Down Survey map of the Barony of Gowran, c.1656 (Figure 13.2)

This map names many of the townlands along and around the proposed route, although sometimes in a slightly different form: *Lough medrume* (Loughmerans), *Troyes wood*, *Talbots Inch*, *Glaydorine* (Glendine), *Bonninsrath* (Bonnetsrath) and *Could Grange* (Coolgrange). Loughmerans, as with much of the land, is marked as a possession of the Ormond family. Coolgrange is indicated as 'church land'. Glendine (*and Ardnemury*) belongs to the Corporation of Kilkenny. Although Dunmore townland is not named on this map, the northern boundary of *Glaydorine and Ardnemury* forms a distinct curving peak where it meets Loughmerans; this is reminiscent of the Dunmore / Loughmerans townland boundary as shown on later maps. The River Nore flows through the area and south to Kilkenny City. An area of land on the east and west banks of the river between Talbotsinch, Troyswood and Loughmerans is marked as '*bog and shrubby*'. A castle is depicted on the western bank of the river, in Talbotsinch, a good distance south in the townland. No further information can be gleaned from this early map.

First Edition Ordnance Survey, 1839, Sheets 14 & 19, Scale 1:10,560 (Figure 13.3)

This represents the first accurate mapping of the study area, which is predominantly agricultural lands bisected by the River Nore. The proposed route travels eastwards from the Freshford Road to the river, passing through three open fields. A property plot and adjacent structure is depicted at the roadside. On the west bank of the river and immediately north of the proposed route lie the demesne lands of Richmond House. The estate grounds contain courtyard buildings near the main house, kitchen gardens / orchards and tree planting. A lime kiln is depicted in a field to the south of the house. An entrance avenue leads east from the main road. An ornamental garden with associated structures (possibly a house and outbuildings) is shown to the northwest, on the far side of the Freshford road, also in Troyswood townland.

The proposed route passes through three large fields to the east of the river, before crossing Bleach Road, which connects Bleach Mills to the south with Dunmore village to the north. This road is remarkably straight for the majority of its length. A field boundary runs parallel to the road on its eastern side, creating a narrow band of ground alongside the road, possibly the remnants of a former mill-race. Recorded enclosure site KK014-065 is depicted on the map to the north of the proposed

route where it runs through the fields east of Bleach Road. A farm-house and outbuildings are shown to the northeast of the enclosure site (KK014-065) and north of the proposed route, accessed via a laneway off the Castlecomer road. Three further recorded enclosure sites (KK014-064, KK019-010 & -011) in the surrounding area are also depicted on this edition. A narrow band of woodland extends north/northeast from Bleach Green in Dunmore townland, where the proposed route passes through before meeting the Castlecomer road.

Second Edition Ordnance Survey, 1900, Sheets 14 & 19, Scale 1:10,560 (Figure 13.4)

Richmond House has been demolished and only the courtyard buildings survive, possibly with a new, smaller residence added and accessed directly off the Freshford Road. The original entrance avenue is now merely a field boundary. Troyswood House and its associated estate buildings and gardens now occupy the site of the possible house and ornamental garden shown on the first edition map to the west. Most of the field boundary marking the line of the possible mill-race has been removed, surviving in part only to the north of the proposed route. The lands on the eastern bank of the river immediately south of the proposed route are marked as liable to floods. The Great Southern and Western Railway (GSWR) has been constructed and runs north/south along the west side of the Castlecomer road. A level crossing is indicated at the approximate point that the proposed route crosses the railway. The farm complex to the north of the proposed route has been expanded, with the addition of a house in a plot on its eastern side and new F-shaped range of buildings replacing the earlier structures. A new access route to the complex runs under the railway line and southeast to the Castlecomer road. Several of the field boundaries in the area have been removed to create larger fields, notably those immediately north of the proposed route on the east side of Bleach Road. Recorded enclosures KK019-010 and KK014-064 are no longer depicted.

Revised Edition Ordnance Survey, 1945-6, Sheets 14 & 19 (Figure 13.1)

The lands on the west bank of the river to the south of the proposed route are now occupied by Auteven Hospital, in Talbotsinch townland. The farm complex and house to the north of the proposed road is named ‘Dunmore House’ on this edition. A stream is indicated along the line of the former entrance to Richmond Demesne and a distinctive circular structure is depicted on the site of the former Richmond House.

13.5.6 Aerial Photographic Analysis

Colour aerial photographs of the lands through which the proposed route travels were examined online for any evidence for cropmarks or earthworks in the vicinity of the study area (www.archaeology.ie & Google Earth). Further analysis was undertaken of colour aerial orthophotographs taken supplied by Clifton Scannell Emerson Associates (2007). The line of the possible mill-race running parallel to Bleach Road is visible on the aerial photographs, south of where the proposed route crosses Bleach Road (Figure 13.5). No further features of archaeological potential were identified in the aerial photographs.

13.5.7 Field Report

A non-invasive field inspection of the proposed route was carried out on 24th January 2013. The weather was dry and mostly clear, with some cloud and light fog. The purpose of a field survey was to assess the present topography and land use along the proposed route, to identify any potential low-visibility archaeological and/or historical features that might be subject to direct or indirect impacts as a result of the proposed works and also to assess the archaeological potential of the landscape.

The field inspection is described on a townland basis along the proposed route from west to east. Each field was assigned a number and the descriptions should be read in conjunction with the aerial photography (Figure 13.5). The topography of the landscape through which the route passes is predominantly undulating, pasture land, though for much of its course the proposed route follows the low-lying, level ground. The grass was short in all pasture fields, with good surface visibility. The fields east of the river, to either side of Bleach Road, were quite water-logged. Many of the original field boundaries have been removed and in some cases have been replaced with electric or post and wire fencing. Where they survive they comprise, for the most part, neat hedgerow.

Troyswood townland

The northern boundary of fields 1 and 2 forms part of the original demesne boundary associated with the former Richmond House, as depicted on the first edition OS map in Troyswood townland (1839; Figure 13.3). The landscape retains none of the character normally associated with a demesne. The former demesne boundary is now a simple bank and ditch construction, with a stream flowing along the narrow ditch and a hedgerow along its north side (Plate 13.1). A folly indicated on the second edition OS map (Figure 13.3), after the demolition of Richmond House, has been incorporated into a modern farm complex that occupies a ridge of high ground close to the site of Richmond House and overlooking the river. As a result of its situation on a height above the river, the folly is visible from the route of the proposed ring road, located c. 350m south (Plate 13.2).

Field 1 has a slightly undulating ground surface, rising up to the west and south from the centre. A stream is depicted flowing through field 1 on the first edition OS map (Figure 13.3) but is absent from later editions. It is likely that the stream was diverted to its present course along the northern boundary of fields 2 and 1 (former demesne boundary; Plate 13.1). Field 2, comprising rough pasture, is relatively level but drops steeply to the river bank at its eastern end, with gorse and bramble overgrowth on the slope (Plate 13.3). The Troyswood / Talbotsinch townland boundary runs along the south side of field 2 and the east side of field 1. The boundary is formed by a stream, lined with trees on the rising slope to Auteven Hospital and its grounds (Plate 13.4).

Loughmerans townland, west of Bleach road

Fields 3 and 4 are bounded by the River Nore to the west and Bleach Road to the east (Figure 13.5; Plates 13.5 & 13.6). A reed-filled stream flowing into the river acts as a boundary between the two

fields, with the smaller field 4 to the south. The river is approximately 10m wide and relatively fast moving, with water levels almost to the top of the banks at the time of the inspection. The river banks are lined with mature trees of varying size, but are otherwise clear of vegetation overgrowth. Both fields 3 and 4 are level and under pasture; they lie within the floodplain of the river and the ground is waterlogged in places. All of the original field boundaries in field 3 have been removed to create a very large field occupying most of the land between the river to the west and Bleach Road, which forms the boundary along the east/northeast.

Loughmerans & Dunmore townlands, east of Bleach Road

Field 5 encompasses a large area of undulating pastureland, subdivided by electric fencing and a path to a large farm complex, and bounded by Bleach Road to the southwest (Figure 13.5). A substantial earthen bank with hedge bounds the east/northeast side of the road, in contrast to the flat ground and hedge forming the opposite road boundary (Plate 13.6). In addition, waterlogging and a change in vegetation is evident in a narrow band of ground (c.15m wide and slightly concave) within field 5 and parallel to the roadside boundary (Plate 13.8). This correlates to the location of the possible mill-race shown on the first edition OS map (Figure 13.3).

The field is level to the southwest and south where the proposed route crosses it. A ridge of high ground runs northwest/southeast through the field, continuing beyond it to the northwest. Two recorded archaeological sites occupy this ridge of high ground: enclosure site KK014-065 in field 5, c.65m north of the proposed route and enclosure site KK014-064 c.235m further to the northwest (Figures 13.1, 13.3 & 13.5). The site of enclosure KK014-065 in field 5 occupies a prominent position above the low-lying ground to the south and west. There are good views in all directions from the ridge, which would have been a prominent feature in the landscape. It overlooks the river to the west and it is likely that the second enclosure site to the north (KK014-064) was also visible from this site. No visible surface trace of the site was identified during field inspection (Plates 13.9 – 13.11).

A reed-filled stream flows along the boundary between field 5 and field 6 to the east (Plate 13.11). Apart from a small section at the base of the ridge which is tree-lined, immediately north of the proposed route, the stream has been cleared of vegetation along its banks. This stream joins another which forms the Loughmerans / Dunmore townland boundary, which runs along the south side of field 6. This boundary is formed by a stream flowing along a deep narrow, channel. It is heavily tree-lined, with an overgrowth of gorse and scrub, and an earthen bank along its southern side.

Field 6 is flat pastureland, rising gently to the southeast corner. The farm complex shown on the historic OS mapping from the 19th century onwards is clearly visible from the proposed route (Figures 13.3 – 13.5; c. 200m north of proposed route). The substantial range of buildings depicted on the second edition map of 1900 are still in use, as is the house, situated in a plot immediately to their east (Plate 13.12; discussed in section 1.6).

An old railway embankment of the former Great Southern & Western Railway survives as a laneway along the eastern boundary of field 6 (Figures 13.4 & 13.5; Plate 13.13). The access road to the house and farm complex, as depicted on the second edition OS map also survives, along with the underpass in the railway embankment (Plate 13.14). The only other remnant of the 19th century railway infrastructure is a culvert that carries the stream flowing from the Loughmerans and Dunmore townland boundary, c. 50m north of the proposed route.

The proposed route crosses Loughmerans and Dunmore townland boundary, and passes through an area almost completely overgrown with scrub and trees where the ground rises steeply to the southeast and more gently to the railway embankment in the east. It then crosses the very end of the embankment, continuing through field 7 (Plate 13.15). This field is level pasture, bisected by the stream flowing via the culvert in the railway embankment. The boundary between fields 7 and 8 is formed by the access road to Dunmore House and farm. The proposed route crosses field 8, a small pasture field, before joining the Castlecomer Road.

13.5.8 Geophysical Survey

A geophysical survey was conducted along the route of the proposed ring road extension in April 2013 by J. M. Leigh Surveys, under licence to the Department of Arts, Heritage and the Gaeltacht (Licence No. 13R41). The main aim of the survey was to identify any potential archaeological remains along the corridor of the proposed road scheme. Initial gradiometer scanning of the route identified several anomalies and areas presenting increased background response. Detailed survey Areas A, B, and C were positioned to investigate (Figure 13.7).

In Area A, many of the isolated responses presented as modern ferrous responses. A curvilinear trend and area of increased responses may be of interest, perhaps representing an area of burning or a burnt spread of material (Figures 13.8 & 13.9). However, there are no clear responses indicative of archaeology, and it is possible that natural variations in the sub-soil have been detected.

Area B is littered with amorphous responses indicative of natural variations, for which no archaeological interpretation can be provided (Figures 13.10 & 13.11). In Area C, to the south of recorded enclosure site KK014-065, parallel negative trends correspond with the location of a former field boundary and parallel linear trends perpendicular to this are indicative of ploughing activity (Figures 13.10 & 13.11). Although there are some linear trends and broad responses within Area C, there is no clear archaeological pattern and these responses are interpreted as most likely to be of natural origin. Magnetic disturbance along the west side of field 5 (Figure 13.7), at Bleach Road, prevented detailed survey to investigate any potential remains of the possible mill-race identified in the cartographic and field-walkover surveys (Figures 13.3 & 13.5).

In summary, while the geophysical survey identified responses of potential interest, there are no clear archaeological patterns evident in the data sets and it is equally likely that natural variations and agricultural practices have been detected. An archaeological interpretation of the results is cautious.

13.6 Description of Existing Environment - *Architectural Heritage*

13.6.1 Introduction

There are many rural buildings in Kilkenny, as throughout the country, that have served varied purposes—domestic, agricultural, educational, religious and industrial. In particular, the expansions of agriculture and population in the late eighteenth and early nineteenth centuries led to the construction of the familiar 'cottage' in farmyards and along roadsides throughout the countryside (McCullough & Mulvin 1987) - what is now commonly referred to as vernacular architecture. There are two main forms of vernacular house plan in Ireland, the direct entry and the lobby entry. Direct entry, where the main doorway of the house enters directly into the main room where the fireplace is, is characteristic of the western half of Ireland, and is often associated with a gabled roof. The gabled roof is a robust design, allowing thatch to be secured to the gable walls. Direct entry houses are derived from the simplest house forms, and in some areas, manifested themselves as byre-dwellings, where the human inhabitants of the house shared with the milk cows, a drain running across the floor dividing the two halves. Lobby entry houses are entered opposite a small wall, often with a window, which juts out between the fireplace and the front door. This form is often associated with the hipped roof, a more elaborate roof form, less susceptible to rain, but more easily damaged by high winds. Such lobby entry, hipped roof houses are typical of Leinster.

Originally thatched, remaining vernacular houses are now largely roofed with corrugated iron, slates or tiles. The visual impact of these buildings, or their associated outhouses in many cases, is often reinforced by the custom of whitewashing the walls (Aalen *et al* 1997). The more substantial two-storey houses visible in the country are often simply elaborations of basic vernacular patterns; the majority developed in the nineteenth century as the dwellings of strong farmers or successful traders.

The rural countryside is also full of secondary buildings or structures that would have been necessary and important for the daily workings of rural life. They include bridges, mills, schoolhouses, dispensaries, railway stations, creameries and forges or smithy's, typically of eighteenth- and nineteenth-century date. Milling activities are of particular interest for the area around the proposed route, focused as they were on the River Nore. Bleach Road, which runs through Loughmerans townland and is bisected by the proposed route, originally connected two large milling complexes and may have run alongside an associated mill-race: Dunmore Woolen Mills c.850m to the north and Bleach Mills (Greenvale Mill, NIAH Reg. No. 12308004) c. 460m to the south. Both mill complexes are depicted on the first edition OS map of 1839 and are known to have been constructed on the site of earlier mills.

Perhaps more alluring, however, is the legacy of the stone manor house, or what became known in Ireland as the 'big house.' Big houses were constructed by planter families in Kilkenny, as elsewhere in the country, roughly between the years 1670 and 1850. By the end of the seventeenth century, the middle-ranking Old English lords who had controlled much of north Kilkenny had been largely supplanted. Landowners like John Purcell of Lismaine were transplanted to Connaught and a suite of New English Protestant landlords, many of whom were Cromwellian officers and soldiers whose arrears of pay had been satisfied by grants of land, were now in situ (Devine et al. Vol. I, p.25). This is the origin of most of the landed estates that were created along the northern River Nore, such as Richview (Bradley) c. 1km to the south of the proposed route.

Such houses are often found near to or on the sites of older ruined castles or tower houses, churches or defunct administrative centres. Big Houses were also often situated within embellished and ornamented demesne land ringed by high walls (McCullough & Mulvin 1987). Demesnes were constructed along the northern River Nore and the great houses were often sited to overlook the river, the waterway became in effect an integral component of the 'designed landscape'. The demesnes exhibit common themes that were heavily influenced by the landscape movement (particularly by the renowned garden architect Capability Brown, 1716-1783): commonly featuring a shelter-belt, ornamental pond, park trees set as standards, tree-lined avenues, a formal garden surrounding the house, a 'wilderness' and a deerpark/open parkland (Devine et al. Vol. I, p.28).

Many of the 'Big Houses' are now in ruins; in many other cases, demesne woodland remains as a vestigial element in landscapes where all trace of the original house, its gate lodges and follies have vanished. Examples of this can be seen at the Richmond Demesne, located immediately north of the proposed route. The original house, entrance avenue and much of the landscaping is now gone, though a folly (later in date) remains on the site above the river. A possible second estate is indicated on the first edition OS map (1839) across the road to the west by an ornamental garden and associated structures, on the site of the later Troyswood House (NIAH Reg. No. 12401414), but has disappeared by the time of the second edition map of 1900 (Figures 13.3 & 13.4).

Rural settlement patterns were completely reorganised around the centres of these estates, the demesnes, while the Enclosure Acts of the eighteenth century had a profound impact on the landscape of north Kilkenny. Whereas during the medieval period land-enclosure had been largely confined to townland boundaries, in the eighteenth century the countryside was parcelled into small fields delineated by substantial banks and ditches. Most of the field-boundaries in the study area can trace their origins to this time and are depicted on the earliest edition OS maps of the area (1839; Figure 13.3), though many have since been removed. Large-scale reclamation of marginal land also took place throughout the area and for the first time much of the flood-plain of the northern Nore was drained and farmed (Devine et al. Vol. I, p.25).

Another, less common, aspect of Irish built heritage landscape in the late eighteenth and nineteenth centuries is the model or estate village. Generally a type of self-contained community, in most cases built from the late eighteenth century onwards by industrialists to house their workers. Although the villages are located close to industrial sites, they are generally physically separated from them and often consist of relatively high quality housing, with integrated community amenities and attractive physical environments. "Model" is used in the sense of an ideal to which other developments could aspire. One surviving example of a model village, Talbot's Inch Village, is located on the banks of the River Nore and represents the closest Record of Protected Structures (RPS) site to the proposed route at c.420m south (RPS C217). The village is also designated an Architectural Conservation Area (ACA) in both the Kilkenny County and the Kilkenny City and Environs Development Plans 2008-2014.

13.6.2 Record of Protected Structures (RPS)

There are no protected structures recorded within Loughmerans or Dunmore townlands or within c.100m of the proposed route in the Kilkenny County Development Plan 2008-2014.

13.6.3 National Inventory of Architectural Heritage (NIAH)

No properties or structures are recorded in the Survey of the Architectural Heritage of Kilkenny (2004/5) within the line of the proposed route. The closest, Aut Even Hospital, lies c.80m south of the proposed route. It is recorded as being of architectural interest with a regional rating (NIAH Reg. No. 12401924-6). A search of the Survey of Historic Gardens and Designed Landscapes (2003-2005) for Kilkenny County provided no results for Loughmerans, Dunmore or their surrounding townlands.

13.6.4 Built Heritage Inventory of the Heritage Audit of the Northern River Nore (Kilkenny County Council 2009)

Richmond House and Demesne (Heritage Audit ID No. KN-106) are recorded in the Built Heritage Inventory. The proposed route at its junction with the Castlecomer Road crosses the former demesne boundary and partially encroaches upon the former demesne lands. Another built heritage site recorded in the Inventory constitutes partial remains of the Great Southern and Western Railway (GSWR), which are crossed by the proposed route. The GSWR, whose main line ran between Dublin and Cork, traverses the study area intermittently linking Kilkenny and Maryborough. The line was completed in 1865 and ceased operation in 1963. Sections of its embankment, railway bridges and/or their abutments survive (Heritage Audit ID No. KN109).

13.6.5 Field Inspection

Properties or structures of architectural heritage merit in proximity to the proposed route.

Five properties were identified during the field inspection within c.100m of the proposed route, two of which were modern: Property AH 6 is a modern detached house and AH 7 comprises 'The Weir' housing development; neither is considered to be of architectural heritage merit. A further two items of

built heritage interest lie c. 200m and c. 350m north of the route respectively, but are clearly visible from it and as such are included in the inventory. None of these items has protected status. For the purposes of this assessment, each property has been assigned a unique ID number (AH #) and is indicated on Figure 13.5.

ID No. AH 1			
Townland	Coolgrange	**Present Use**	Cottage & outbuilding
Inspection Date	24/01/013	**Original Use**	Cottage & outbuilding
Status/Protection	None	**Type**	Cottage & outbuilding
Plate No	13.16	**Significance/Interest**	Vernacular architecture
Description			
Composition	A derelict cottage and outbuilding, set within a small farmyard. Both structures are very overgrown.		
Site	The plot is set in a dip, well back from the Castlecomer Road and is accessed off the Thornback Road.		
History	Depicted on the second edition OS map of 1900 (Figure 13.4)		
Impact			
Distance	c. 35m west		
Type & Quality of Impact	No impact		

ID No. AH 2			
Townland	Talbotsinch	**Present Use**	Hospital
Inspection Date	24/01/013	**Original Use**	Hospital/Infirmary
Status/Protection	NIAH Reg. No. 12401924-6	**Type**	Hospital
Plate No	13.4	**Significance/Interest**	Architectural, Historic
Description			
Composition	The essential attributes of a well-composed cottage hospital remains. Built to designs prepared by Albert Edward Murray (1849-1924) exhibiting Arts-and-Crafts qualities.		
Site	The site is well screened from the proposed route by the trees along the Loughmerans/Talbotsinch townland boundary, while those buildings associated with the original cottage hospital are eengulfed by a later (1982) range of little inherent architectural heritage merit.		
History	The Aut Even Hospital complex established in the early 20th century by Ellen Odette Desart (née Bischoffsheim), 4th Countess of Desart (1857-1933).		
Impact			
Distance	c. 80m south		
Type & Quality of Impact	No impact		

ID No. AH 3			
Townland	Troyswood	**Present Use**	Farm
Inspection Date	24/01/13	**Original Use**	House & Demesne
Status/Protection	None	**Type**	House & Demesne
Plate Nos	13.1 & 13.2	**Significance/Interest**	Built heritage
Description			
Composition	Richmond house and its former demesne were located on the west side of the River Nore about 1.6km north of Kilkenny City. The demesne measured approximately 700m N-S by 400m W-E. It was bordered by the river on its eastern side and the Kilkenny-Threecastles road to the west. Primary access to Richmond house was along a partially tree-lined avenue leading from the Kilkenny-Threecastles road.		
Site	The two houses and most of the wilderness areas of the demesne do not survive today, although the outline of the formal garden at Troyswood and Vestiges of the avenue leading to Richmond house are still apparent in a modern access lane from the Castlecomer Road to the present farmyard. A later folly, possibly early 20th century, survives on the site of the original house, enjoying its position overlooking the river. The former demesne boundary on its south side is now a simple field boundary and the landscape retains none of its demesne character.		
History	The house and demesne are depicted on the first edition OS map of 1839 (Figure 13.3). A later folly, possibly early 20th century, is depicted on the revised edition OS map of 1945-6 (Figure 13.1). The history of the Richmond House is not well known. Land of 21 acres at Richmond was put up for let in 1802 'with or without' the letting of lands of Troyswood. It was advertised for rent again in 1805 after some refurbishments had taken place including the construction of a coach house and stabling for ten horses. It was put out for rent a third time in 1811. James Edmond Scott, of Anngrove, Mountrath in 1815 advertised the house for sale, 'in perfect condition' and ideal for a hunting lodge. The next newspaper reference to the house is in 1831 when a Mrs Byrne is mentioned. She advertised the house to let in 1840 and possibly again in 1844, while the last reference concerned James Edmond, Esq. of Richmond in 1856. (Source: Heritage Audit of the Northern River Nore, Volume 2, Built Inventory)		
Impact			
Distance	0m to former demesne boundary & c. 350m to folly		
Type & Quality of Impact	Given the absence of the house, the loss of demesne character and replacement of the original boundary, there is no direct impact on the former Richmond Demesne. The folly, which is of architectural interest and occupies the original house site, is visible from the proposed route; as such, there is a visual impact on it and an effort should be made to screen the structure from the route. (Refer to Chapter 12.0, which deals with Landscape & Visual assessment)		

ID No. AH 4			
Townland	Loughmerans	**Present Use**	Farm complex
Inspection Date	24/01/13	**Original Use**	Farm complex
Status/Protection	None	**Type**	House & Farm
Plate Nos	13.12, 13.17 & 13.18	**Significance/Interest**	Built heritage
Description			
Composition	A nineteenth century three-bay, two-storey detached house, situated in its own plot. Carriage-arch survives in the adjoining garden wall on the east side of the house. A substantial range of stone-built, slate-roofed farm buildings occupy the site adjacent to the west. Both the house and the associated farm buildings are an attractive example of an intact nineteenth-century farm complex. The entire complex is considered to be of built heritage interest.		
Site	Set in undulating pastureland, the complex retains the original access via an underpass in a surviving embankment of the Great Southern & Western Railway. The landscape appears little changed from the time of construction of the farm complex and railway in the nineteenth century.		
History	An earlier farm-house and outbuildings are shown on the site of the present farm buildings on the first edition OS map of 1839 (Figure 13.3). At some time before the survey for the second edition OS map of 1900 (Figure 13.4), the present house and associated range of farm buildings were constructed and its access altered for the new railway line. Named as Dunmore House on the revised 1945-6 edition OS map (Figure 13.1).		
Impact			
Distance	c. 200m north		
Type & Quality of Impact	Indirect impact on the setting of the farm complex. The visual impact on the complex is significant and should be mitigated with effective screening. (Refer to Section 12, which deals with Landscape & Visual assessment)		

ID No. AH 5			
Townland	Dunmore	**Present Use**	Laneway
Inspection Date	24/01/13	**Original Use**	GSW Railway
Status/Protection	None	**Type**	Embankment
Plate Nos	13.13 & 13.14	**Significance/Interest**	Built heritage
Description			
Composition	A section of the mid-nineteenth century railway embankment. The railway line itself has been replaced by a path / laneway, lined with neat hedgerow and some trees.		
Site	In addition to the embankment itself, an underpass and a culvert also survive of the original railway infrastructure, though neither will be directly impacted by the proposed route.		
History	Depicted on the second edition OS map of 1900. The Great Southern and Western (GSW) railway whose main line ran between Dublin and Cork, traverses the study area intermittently linking Kilkenny and Maryborough. The line was completed in 1865 and ceased operation in 1963.		
Impact			
Distance	0m		
Type & Quality of Impact	Direct impact on the southern-most end of the embankment.		

13.7 Description of Existing Environment - Cultural *Heritage*

13.7.1Townland Boundaries

Townlands are a unique feature in the Irish landscape. They are one of the oldest land divisions in the country, and their origins are undoubtedly of great antiquity, most certainly pre-Norman. They existed well before parishes or counties. Townland boundaries can take the form of natural boundaries or routeways as well as artificially constructed earthen banks and ditch divisions. They are predominantly formed of substantial boundaries which are usually distinguishable from standard field division boundaries. There are 62,000 townlands in Ireland, grouped into civil parishes, then counties and finally provinces. The proposed route crosses the Loughmerans / Dunmore townland boundary, which is currently formed by a stream and is indicated as such on the first edition OS map (1839; Figure 13.3). It also appears to be represented on the earlier mid-seventeenth century Down Survey map (see Section 1.5.6).

13.7.2Townland Names

Townland names are an invaluable source of information not only on the topography, land ownership, and land use within the landscape, but also on its history, the archaeological monuments and the folklore. Where a monument has been forgotten or destroyed, a placename may still refer to it, and may therefore indicate the possibility that remains may survive below the ground surface.

Townland names were recorded by the Ordnance Survey surveyors in the 1830s and 1840s, when the entire country was mapped for the first time. The mapmakers, soldiers and antiquarians who collected the placenames and local history varied in their interests and abilities. While most placenames were anglicised or translated relatively accurately, some were corrupted virtually beyond recognition, while others had been given entirely different names by new landowners or settlers. At this time surviving placenames connected with fields, hills and hollows, rivers and streams, settlement clusters, valleys and headlands and islands and bays were also recorded.

The placenames found along the proposed route and in its immediate environs are a mixture of Irish and English names referring to topography, archaeological sites and land use. They also provide a good picture of the influences of the strong Anglo-Norman and English presence at Kilkenny.

Baun (and the English 'bawn') is an anglicisation of the Irish *bán*, which translates as white and can represent a grassy field or a cow-keep. Another placename referring to the topography is **Glendine**, *gleann doimhín*, meaning 'deep glen' (O'Kelly 1969a, 24). While the second half of the placename **Loughmerans**, *Loch Méadhrán* meaning 'Mearan's Lough', must refer to a now dried up lake.

The Irish for **Coolgrange** is '*Cúl gráinsíghe*', meaning 'hill of the grange' or 'hill of the granary'. A grange was originally an area of land some miles away from an urban-based monastery where in medieval times food was grown for the monastery. The suffix 'grange' in Coolgrange suggests that these lands were a part of a monastic farm, as is known to be the case with other lands in this area. Baun townland, for example, is listed in the civil survey of the 1650's as being in the possession of Jerpoint Abbey, which records '*two messuages forty acres of arable, forty of pasture and wood with appurtenances in Baun, annual value besides apprise 540*' (O'Donovan, II, 263). The townland is designated 'churchland' on the accompanying Down Survey map of 1656 (Figure 13.2).

Dunmore may be an anglicisation of the Irish *Dún Mór*, meaning 'big fort' and O'Kelly notes that the townland was anciently called *Baile Muicín* or 'Muicín's Homestead' (1969a, 35). It is, however, marked on Sir William Pettit's map of 1686 as *Domhnachmore* or *Donoghmore*, meaning 'Great Church', suggesting an ecclesiastical association for the townland (O'Donovan, I, 38). According to O'Kelly, the old parish church in the townland was called *Domhnach Mór na Trionóide Naomtha* meaning 'great church of the Holy Trinity' (1969a, 35). Another reference to an archaeological monument is contained in **Raheenagun**, where the prefix 'raheen' derives from the Irish *Rathín* meaning 'little fort'. O'Kelly (1969a, 24) names this as 'Ráithín na gcon', little rath of the hounds.

Troyswood is indicative of the strong Anglo-Norman presence in the area and probably refers to Theobald Troye, one of the tenants paying knight's fees assigned in dower to Gilbert de Clare's widow, listed in 1314/15 (*http:// www.rootsweb.com/ ~irlkik/ history/ knights_ fees.htm*). The townland was formed from the union of two ancient districts (Donore and Farranbroc) in 1454 when the Troy

family came into possession of these lands. Donore or *Dún Uabhar*, meaning 'proud fort', remained in the possession of the Black Abbey friars until 1540 (O'Kelly 1969b, 25). Given the presence of a ringfort at the northern end of the present townland, the district of Donore is likely to have occupied this area. Farranbroc derives from the Irish *fearann broc* or 'badger land'.

Talbotsinch might also refer to this period in Kilkenny's history, recording the presence of another Anglo-Norman family, the Talbots. The suffix '-inch', from the Irish *inse* which can mean 'water-meadow', might refer to the topography in this area close to the river.

13.7.3 Features of cultural heritage interest within or in the vicinity of proposed route

The proposed route will cross a section of the Loughmerans / Dunmore townland boundary.

13.8 Impacts on Existing Environment

13.8.1 Introduction

The nature of the following impacts is assessed with reference to the Glossary of Impacts provided in the Advice notes on Current Practices in the preparation of Environmental Impact Statements, EPA, 2003, Guidelines for the Assessment of Architectural Heritage Impact of National Road Schemes, NRA, 2006 and Guidelines for the Assessment of Archaeological Heritage Impact of National Road Schemes, NRA, 2006. Impact ratings and significance are detailed in Appendix N. The impacts are classed as direct, indirect and no predicted, with significance ratings of profound, significant, moderate, slight and imperceptible. These levels have not been adopted in relation to potential archaeological sites or areas, as the archaeological significance of such sites will only be established through invasive testing, for the purposes of the EIS these are seen as potentially significant until proven otherwise. The predicted impacts detailed below are based on engineering details provided at this time.

13.8.2 Archaeological Heritage

Recorded Archaeological Sites

While there are no recorded archaeological sites located along the line of the proposed route, recorded enclosure site KK014-065 lies c. 60m north in field 5 (Figures 13.1 & 13.5). No visible trace of the site could be identified during field inspection or by an examination of aerial photography and its exact location could not be confirmed. Given the morphology shown on the first edition OS mapping (Figure 13.3) and the topography of the site on a ridge of high ground, it is likely that the enclosure site was a ringfort. Ringforts were not simple isolated homesteads and should be considered within their contemporary settlement landscape, which would have consisted of unenclosed settlements, farms and fields, route-ways and natural resources. Although these elements have left no obvious trace in the area, the potential for revealing these features has been demonstrated on other road schemes, where archaeological excavation and geophysical survey has revealed annexes and complex field systems associated with early medieval enclosure sites. Souterrains are also found in association with

ringforts and, by their nature, can go undetected for long periods of time and are often discovered by accident when heavy machinery causes them to collapse.

The proposed route runs along the low-lying, waterlogged ground at the base of the ridge to the south that is prone to flooding, thus avoiding what is likely to have been the main area of habitation. Archaeological excavation of the previously unknown bi-vallate ringfort at Blanchfieldsland, however, revealed numerous associated features down-slope from the site where hill-wash had afforded them protection (section 1.5.4). There remains, therefore, significant potential that associated sites or features may survive beneath the surface within the vicinity of the recorded site.

Areas of archaeological potential

Although the known archaeological record points to this as a well-established settlement area during the early medieval and later periods, it is highly likely that the river has long been the focus of settlement and activity, acting as a major conduit for trade and communications from the prehistoric period onwards. Water travel was often safer and more expedient than moving by road, making such an artery a valuable resource, particularly for the movement of goods, especially heavy items such as stone or timber (Doran 2004, 61). Human activity during the prehistoric period was confirmed in the wider area during excavations in advance of the N77 ring road extension from the Dublin Road to the Castlecomer Road in 2003, in the form of an Early Bronze Age funerary pit revealed in Garrincreen townland. The proposed route will have a direct, negative and potentially significant impact on any subsurface features which may survive within these areas of archaeological potential:

- ***Riverine Environment***

  The River Nore and its environs are regarded as highly sensitive and are considered to have an intrinsically significant archaeological potential unless proved otherwise by archaeological investigation. The River Nore is an important waterway, providing a routeway between the open sea and inland. Its importance is attested to by the number of recorded monuments in its vicinity, it has attracted a great deal of human activity through the ages. While there are to be no works undertaken within the river itself, the archaeological potential of the river banks/ environs of the river is significant.

- ***River bank and environs potential:***

  It is possible that subsurface prehistoric or later settlement activity may come to light in the riverside greenfield areas in fields 2 and 3 (Figure 13.5).

- ***Potential for Milling activity***

  The cartographic sources indicate that there was a thriving milling industry in this area, along the banks of the River Nore, with woollen and bleach mills located to the south in Dunmore townland (Bleach Mills) and north at the 'Dunmore Woollen Manufactory'. The nineteenth-

century historic maps depict these mill buildings, connected by Bleach Road, and both are thought to have been constructed on the site of earlier mills. The line of a probable mill-race can be traced on the first edition OS map, running almost the entire length of Bleach Road along its eastern side. A section of this feature is also visible on the aerial photography and could be identified in the field (Figure 13.5). The proposed route crosses this feature where it enters field 5. There is also the potential that additional features or structures associated with the milling industry may survive subsurface along the east bank of the river.

- ***Wetland Areas***

  Wetland or boggy areas are considered to be of high archaeological potential; significant waterlogging was evident in the level, low-lying fields 3, 4, 5 and 6, all in proximity to streams (Figure 13.5). Wetland provides unusually good preservation conditions for organic materials, such as wood, leather, textiles and human remains. A number of streams flow through the area to the River Nore. This topography and the proximity of streams as a water source is typical of the locations in which *fulachta fiadh* (or burnt mounds) are found. The presence of burnt mounds or *fulachta fiadh* is often indicative of Bronze Age seasonal communal activity in river valleys and boggy ground.

- ***Greenfield Potential***

  The proposed route travels through predominantly greenfield, agricultural lands. As agricultural development tends to obscure surviving subsurface archaeology, there is a high potential that archaeological features or finds survive beneath the surface. There is a potential that previously unknown subsurface archaeological features and finds will be uncovered in any previously undisturbed greenfield areas along the proposed route. This potential is supported by the recorded archaeological sites and archaeological investigations in the vicinity of the proposed route, which attest to the importance of the area for settlement since at least the prehistoric period.

Loughmerans / Dunmore townland boundary

This townland boundary appears to be represented on the earliest cartographic source for the area, the c. 1656 Down Survey map (Figure 13.2), and, as a natural topographical boundary, is likely to be of greater antiquity. The proposed route will have a direct and negative impact on this boundary.

13.8.3 Architectural Heritage

Structures assessed for architectural merit

A section of mid-nineteenth century railway embankment (AH 5; Figure 13.5) is one of the few surviving elements of railway infrastructure of the Great Southern and Western rail line to Kilkenny. It is considered to be of built heritage interest and part of it will be directly and negatively impacted by the proposed route.

No other features of architectural heritage merit will be directly impacted by the proposed road; however there is an indirect visual impact on a folly (AH 3) and a house and farm complex (AH 4). Buildings indirectly or visually impacted owing to their proximity to the proposed route are dealt with in the Landscape and Visual Assessment chapter of the EIS, which deals with screening.

13.8.4 Cultural Heritage

Features of cultural heritage interest

The proposed route will directly and negatively impact upon a section of the Loughmerans / Dunmore townland boundary.

13.8.5 Cumulative Impact

There is no cumulative impact on archaeological, architectural or cultural heritage.

13.8.6 Do-Nothing Impacts

In the “do-nothing” scenario the proposed route would not be constructed and therefore there would be no adverse impacts to any archaeological sites or features of archaeological potential or as yet undiscovered subsurface sites, nor to any features of architectural or cultural heritage.

13.9 Mitigation Measures

13.9.1 Introduction

The mitigation strategy outlined details the techniques that will be adopted at the pre-construction stage to ameliorate the predicted impacts.

13.9.2 Archaeological Heritage

Areas of archaeological potential

Test Excavation

Given the proximity of recorded enclosure site KK014-065, the presence of a possible mill-race and the potential for discovery of previously unknown sites or features along the proposed route, it is proposed that a programme of strategic archaeological test excavation be undertaken within the land acquisition area of the proposed route. The purpose of this blanket testing strategy is to determine the location, date, nature and extent of any previously unknown archaeological sites. The results of the geophysical survey can be used to inform the archaeological test excavation, by incorporating into the blanket testing strategy the responses of potential archaeological interest that were identified by the survey in Areas A and C (Figures 13.7, 13.8 & 13.10). The testing strategy should also be cognisant of the possible mill-race identified in the cartographic and field-walkover surveys along the west side of field 5 at Bleach Road (Figures 13.3 & 13.5). This work should be carried out by a licensed archaeologist.

On the basis of the test excavation results, further mitigation may sought by the National Monuments Section of the DAHG in the form of additional test excavation, preservation *in situ* (by avoidance or design) or resolution by archaeological excavation.

It is proposed that any archaeological features revealed by the test trenching, which will be directly impacted by the proposed works, will be resolved by archaeological excavation, recording and publication of results. This process ensures that the features are recorded and excavated in advance of development. Excavation results in the removal of archaeological remains from their natural environment. Archaeological excavation ensures that this removal is systematically and accurately recorded, drawn and photographed, providing a paper and digital archive and adding to the archaeological knowledge of a specified area. The detailed technical reports arising from this will form part of the national archive of archaeological data in the Record of Monuments and Places record curated by the DAHG.

Archaeological features or sites revealed by the test trenching, which will be directly impacted by the proposed works, may also be preserved *in situ* (by avoidance or design), where deemed appropriate by the National Monuments Section of the DAHG.

It is anticipated that all archaeological resolution will be completed preconstruction. This is in accordance with the Code of Practice between the NRA and the Minister for Arts, Heritage and the Gaeltacht (formerly Arts, Heritage, Gaeltacht and Islands), 2000.

13.9.3 Architectural Heritage

Structures assessed for architectural merit

A section of the nineteenth-century railway embankment (AH5) will be recorded by a suitably qualified archaeologist.

13.9.4 Cultural Heritage

Features of cultural heritage interest

A section of the Loughmerans / Dunmore townland boundary will be recorded by a suitably qualified archaeologist, if the boundaries are to be removed.

13.10 Residual Impacts

No residual impacts are envisaged, as all archaeological, architectural and cultural heritage issues will be resolved at the pre-construction and construction stages of the development.

13.11 Construction Impacts and Mitigation Measures

All archaeological, architectural and cultural heritage issues will be resolved at the pre-construction stage of the development.

The contractor or sub-contractor working is subject to the relevant planning legislation and to the National Monuments legislation and should comply with national policy guidelines and statutory provisions for the protection of the archaeological, architectural and cultural heritage.

For works that may be located outside the CPO of the approved development such as site compounds and other temporary works areas or ancillary works such as haul roads that are directly related to the proposed route, the contractor or sub-contractor is subject to the relevant planning legislation. The National Monuments Section of the DAHG should be contacted in advance of such works so that advice may be issued with regard to the relevant permission required to carry out the work.

13.12 Interaction and Inter-relationships with other Environmental Effects

Cultural Heritage impacts will interact with:

- Noise and Vibration: Any impacts of Noise and Vibration associated with the construction or operation of the Scheme on the cultural heritage is discussed in Chapter 11.0 Noise and Vibration.

13.13 Monitoring

Monitoring is discussed in Section 13.9 above.

13.14 Reinstatement

The full nature and extent of required reinstatement will be established in the construction phase in conjunction with the relevant authorities.

13.15 Difficulties Encountered in Compiling this Information

No difficulties were encountered.

14.0 MATERIAL ASSETS

14.1 Introduction

This chapter of the EIS provides a description of the impact of the Kilkenny Northern Ring Road Extension road development on Material Assets. The principal land use within the proposed road development is agriculture.

14.2 Assessment Methodology

This assessment was also based on a desk study which included an inspection of the Land Registry records and information received from landowners. There are 3 farm holdings that will be affected by the proposed road development. The owner of each of these farms met with Kilkenny County Council in July 2013. The land take required by the proposed road development is shown in Figure 14.01.

14.3 The Existing Environment

The study area is predominantly agricultural in nature and a variety of farm uses occur within the area. A total of 3 privately owned farm holdings will be affected by the proposed road development. Of the farming properties affected by the proposed road development, all are full time farmers.

Farming Activities

The main farming activities occurring on the 3 farm holdings impacted on by the proposed road are dairy, cattle and crops. None of the land is used for tillage or sheep.

Crops

The only crop within the study is grass grown for silage.

Soil

The majority of agricultural lands quality along the proposed road development is fair to good quality. Very good lands are described as the best quality faring lands in terms of productivity and financial value, on a national basis. A proportion of the agricultural lands is of less than good quality and includes areas of marshy land.

Drainage

The study area is traversed by a number of natural drainage lines (rivers and streams), as well as drainage networks installed for agricultural purposes (including open drainage).

14.4 Potential Impacts of the Proposed Scheme

The proposed road development will impact on farm holdings in the study area during both the construction and operational phases. The main impacts associated with the proposed road development relate to the following:

- Land take
- Severance of property
- Severance of access to local road network
- Disturbance
- Drainage

Land Take

Overall, the proposed road development will result in a total agricultural land take of approximately 7.15ha, 6.05ha of which is from 3No. landowners and is used for agricultural use. This loss to agricultural production, while significant to the individual farmers, is not significant on a national or county level.

It is acknowledged that the loss of land through land take has the potential to have some impact on the many schemes that farmers may be involved with, for example Livestock Premia, Headage, Area Aid Payments, and the Rural Environment Protection Scheme.

Severance

The proposed road development will cause the severance of approximately 13ha of agricultural land from main farming blocks. All of the farm holdings (3 holdings) along the proposed road development are impacted in some way by land severance, i.e. the proposed road development will result in the separation of some farming lands from the main farming block. For 2 of the farm holdings, underpasses will be provided under the proposed road to access the severed portions of land. The other holding will have access to the local road network from the severed land.

Severance of Access to Local Road Network

The proposed road development does not result in severance of access to the local road network for any farm holdings. However, it will result in the severance of access to the local road network for two of the severed portions of land. Alternative access will be provided for these farms in the form of underpasses under the proposed road, although the travel distances will increase in some cases.

Removal of Farm Buildings

No farm buildings will be removed as a result of the proposed development.

Disturbance

Potential construction and operational impacts arising from the proposed road development include the proximity of the proposed works and the proposed road development to dwellings, farm buildings and livestock, potential nuisance from increased noise levels or dust emissions and potential impacts of dust on crops.

Some agricultural activities could be slightly affected depending on the timing of different sections of the works and any temporary access arrangements agreed between the Contractor and landowners.

Drainage

A number of farms have installed artificial drainage systems in order to improve the quality of their land. Drainage systems will be impacted to a minor degree on some farms by the proposed road development.

Impact Assessment Criteria

All of the farm holdings were assessed separately as each farm will be uniquely impacted by the proposed road development. Each of the potential impacts (i.e. land take, severance, disturbance etc.) were assessed in relation to each individual farm holding and an overall impact assessment was determined for each farm, based on the impact criteria described below:

- **Slight impact** occurs when the proposed road development is located close to the boundaries of properties, the land take is relatively small, and disturbance to the operation of the farm holding is minimal.
- **Moderate impact** occurs where there is an area of land acquired and/or separated within the farm holding and there is some disturbance to the operation of the holding which can continue but is likely to require a minor change in farm management.
- **Significant impact** occurs where there is an area of land acquired and/or separated within the farm holding and there will be significant disturbance to the operation of the holding, which is likely to require a change in farm management.
- **Severe impact** occurs where there is a relatively large area of land acquired and/or separated within the holding and the disturbance to the operation of the farm is such that it is unlikely that the existing farming operation can continue.

The impacts on the individual farms is summarised in Table 14.1, which are presented at the end of the chapter.

14.5 Mitigation Measures

Land Take

The compulsory acquisition of land is subject to the statutory code governing the assessment of compensation for such acquisition. Compensation will be considered on an individual farm holding

basis and is dependent on a variety of factors, such as land take, severance, injurious affection, disturbance and potential damage to the future viability of the farm. Table 14.1 provides details of the areas of land take for each farm holding.

Severance

The mitigation measures proposed for the operation of the proposed road development fall into the following main categories:

- Compensation under the statutory code; and
- Maintenance of existing access or provision of alternative access to dwellings, farm buildings and severed lands.

In determining appropriate mitigation measures for maintaining access, each farm holding is considered on an individual basis and the appropriate mitigation measures applied to each site. Access will be provided to all severed land parcels during the construction phase, where practicable. Close liaison between the contractor and the individual farmers will minimise the difficulties caused by restriction of access to severed land parcels.

Drainage

In any cases where impeded drainage during construction is likely to cause difficulties to a particular landowner, temporary measures will be put in place to minimise the impact.

Where artificial drainage systems installed by the landowner will be disrupted permanently by the proposed scheme they will, if feasible, be connected to the new road drainage system to restore the system to its original operating efficiency. Either approach will have a positive impact on the farm holdings as the proposed road drainage system will be designed to handle greater capacity of run-off than any existing drainage systems. Drainage impacts are further dealt with in Chapter 4 Description of the Proposed Development and Chapter 9 Soils, Geology and Hydrogeology.

Construction

Mitigation measures for construction impacts relating to potential increases in dust and noise levels are discussed in the relevant chapters (Chapter 10 Air Quality and Climate, Chapter 11 Noise and Vibration).

The land required for the proposed development will be acquired in advance of construction and fenced at the start of the construction process. This will ensure minimal impact on adjoining agricultural land.

14.6 Residual Impacts

The residual impacts from the proposed road development are land take, severance, injurious affection and disturbance. All landowners will be compensated on an individual basis in accordance with the statutory code governing compensation. Of the 3 farm holdings assessed, it is determined that after mitigation, all holdings will have a moderate impact.

Rural Farmland

The proposed scheme will involve land take from rural farmland, which is not zoned for development in the Kilkenny County Council Development Plan 2008-2014, and amounts to 6ha in total. Table 14.1 below summarises the land take required and the impacts arising for each land owner.

Table 14.1 – Impact on Rural Farmland

Chainage	Description	Reason for Acquisition	Land Acquired (ha)	Impact
10 - 420	Rural Farmland	Kilkenny Northern Ring Road Extension	2.041	Moderate
440 - 800	Rural Farmland	Kilkenny Northern Ring Road Extension	1.678	Moderate
810 - 1390	Rural Farmland	Kilkenny Northern Ring Road Extension	2.714	Moderate

Mitigation Measures

Compensation payments for lands to be acquired as a result of the Scheme will be agreed between the relevant landowners and Kilkenny County Council. Where part of a field is to be acquired replacement boundary treatment will be provided. Where access to a field is affected the access will be reinstated or an alternative access will be provided, in agreement with the relevant landowners. Where severance occurs an underpass will be provided.

14.7 Interaction and Inter-relationships with other Environmental Effects

Material Assets impacts will interact with:

- Groundwater: Dewatering of groundwater to facilitate construction activities has the potential to lower groundwater levels thereby impacting on groundwater users. However, it is unlikely that significant dewatering of groundwater will be required, or that groundwater will be used as a temporary water supply during construction. Further details are outlined in Chapter 9 of this EIS.
- Landscape: Landscape proposals that will minimise the visual impacts on properties are discussed in Chapter 12 of this EIS.
- Cultural Heritage: Buildings affected as a result of the Scheme have also been assessed from a cultural heritage perspective as described in Chapter 13 of this EIS.

- Noise: Abatement measures to reduce the impact of noise on nearby farms during the construction and operational phases of this project are discussed in Chapter 11 of this document.
- Air: Exposure to windblown dust, other particulates and emissions of pollutants from road traffic are important considerations for farm residents and animals. Abatement measures described in Chapter 10 are important to ensure residents have a pleasant living environment.
- Water: Drainage systems outlined in Chapter 3.0 and 8.0 of this document will avoid impacts on existing water quality from the discharge of runoff and will ensure that farm livestock using the local water supply for drinking will not be impacted by poor water quality.

14.8 Monitoring

The Project Liaison Officer will continue to liaise and engage with affected farmers or their representatives in relation to the supervision of agreed accommodation works in accordance with the procedures outlined in the agreement between the Irish Farmers' Association (IFA) and the Department of the Environment and Local Government and the National Road Authority (NRA).

14.9 Reinstatement

Not applicable.

14.10 Difficulties Encountered in Compiling this Information

Not applicable.

15.0 SUMMARY OF EVIRONMENTAL COMMITMENTS

The environmental commitments outlined in Tables 15.1 – 15.9 below are an integral part of the application for approval of the Scheme.

Best practice and good construction practice when referred to in this document refer to measures contained in current guidance documents which set out the practice and procedures for environmental protection during construction and operational phases.

Where Legislation, Standards or Guidance Documents are referred to it should be noted that at the times of construction or operation of the Scheme any amendments to these documents are applicable.

The purpose of this chapter of the EIS is to provide a summary of the main commitments under each of the environmental headings listed. Full details on the commitments are available in the individual EIS chapters.

15.1 General

Number	General Commitments
1.1	Contract documents will include a requirement to implement and maintain an Environmental Operating Plan (EOP), having regard to the Guidelines for the Creation, Implementation and Maintenance of an EOP (NRA, 2007)
1.2	The commitments contained in this EIS will be included in the EOP which will detail implementation methodologies for all environmental commitments.
1.3	All construction stage mitigation measures will apply to the construction site and all construction compounds, wherever they may be located.
1.4	All works undertaken as part of the ground investigation contract will be undertaken in accordance with recognised best practice procedures in order to ensure that they do not result in any environmental impacts.
1.5	A Project Construction and Demolition Waste Management Plan will be prepared and maintained for the Scheme.
1.5	Any unsuitable excavated material will be removed from the site and disposed of in accordance with all relevant Waste Management Legislation.

15.2 Human Beings – Chapter 6.0

Number	Human Beings Commitments
	This Summary of Environmental Commitments and the EIS in its entirety should be referred to in order to gain a complete understanding of mitigation which will be implemented in order to avoid, reduce or remediate potential impacts on human beings.
2.1	The EOP will include measures for the provision of information to the public, communication and complaints procedures, maintenance of access, and traffic management procedures. This will serve to minimise potential impacts on existing commercial activities, tourism and residential areas.
2.2	Landowners and local residents will be informed in advance of the date of commencement of construction works and will be provided with information on the intended construction programme where appropriate.
2.3	A Traffic Management Plan will be included in the EOP as part of the implementation of the Mitigation Strategy. Traffic management measures will be undertaken in compliance with any relevant authorities including the Gardaí. Information on alternative access/traffic arrangements will be provided to landowners and local residents in advance of construction commencing.
2.4	Access to adjacent agricultural lands will be maintained at all times during the construction phase, and temporary accesses will be put in place where necessary.
2.6	The existing road network will be maintained and appropriate signage will be put in place.
2.7	Cycling and pedestrian facilities will be provided along the length of the Scheme, which will tie-in with existing facilities.
2.8	Uncontrolled pedestrian crossings points will be provided at the Castlecomer Road Roundabout, the Freshford Road Roundabout and the T-junction with the Bleach Road.
2.9	Relevant tourism signage will be provided along the Scheme.

15.3 Terrestrial Ecology – Chapter 7.0

Number	Terrestrial Ecology Commitments
3.1	During construction, measures will be put in place in order to mitigate against the spread of alien invasive species such as Japanese Knotweed and Himalayan Balsam. The measures outline in the NRA document entitled ‘Guidelines on the Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads, 2008’ will be used where necessary.
3.2	A pre-construction survey will be carried out that will check for any otter holts within or close to the land take required for the Scheme. The survey will extend c. 150m from the

	river crossing, as disturbance to breeding otters may result from construction works.
3.3	Where feasible, construction works will be limited to daylight hours in the vicinity of the River Nore in order to allow otters and other wildlife to forage along the watercourses at dawn, dusk and during the night. Access to the riverbank for such animals will be maintained during construction.
3.4	The proposed bridge will ensure the retention of existing bankside vegetation to ensure the bankside can continue to be used as a natural habitat for otters, badgers and other wildlife.
3.5	A detailed bat survey of trees to be felled will take place within the active bat summer season.
3.6	Tree felling will be confined to the spring months of March, April and May or autumn months of September, October, or November (felling during the spring or autumn months avoids the periods when the bats are most active).
3.7	Any ivy-covered trees which require felling will be left to lie for 24 hours after cutting to allow any bats beneath the cover to escape.
3.8	Lighting appropriate for a road in a rural setting will be installed along the Scheme.

15.4 Aquatic Ecology – Chapter 7.0

Number	Aquatic Ecology Commitments
4.1	An invertebrate and aquatic plant survey in the affected section of the River Nore will be carried out immediately prior to construction commencing.
4.2	The bridge structure should not require any in-stream construction works within the River Nore, however, should in-stream construction works be required they will only be undertaken during the period July to September inclusive.
4.3	Preparatory and completion works related to the in-stream construction, such as the construction or removal of temporary access platforms, may be considered acceptable during June and October subject to agreement with Inland Fisheries Ireland (IFI).
4.4	Methodologies for construction activities will be developed in accordance with current recognised best practice.
4.5	The appointed Contractor will establish contact with the IFI prior to the commencement of works and will be required to continue to liaise with IFI throughout the construction process. Contractors will be in possession of, and familiar with the contents of, *"Control of water pollution from construction sites – Guidance for consultants and contractors"*, published by the Contruction Industry Research and Information Association.
4.6	Measures will be put in place to ensure that suspended solids in any runoff into the River Nore from the construction area, machinery access routes or any other land based source

	does not exceed 25mg/l. The following measures will be put in place: • Existing vegetation will be retained where possible. • Within the construction site the extent of ground stripped of existing cover/ vegetation will be kept to the absolute minimum required for construction. • The construction site will be stripped on a phased basis to minimise the area of soil exposed at any one time. • Eroded sediments will be retained on site with erosion and sediment control structures such as sediment traps, silt fences and sediment control ponds. • Temporary stockpiled material located in close proximity to the River Nore will be covered to prevent run-off from entering the watercourse. • Cut-off ditches will be constructed to prevent surface water run-off from entering excavations. • Temporary access roads will be fully stoned to prevent erosion of fines and/or rutting by site traffic. • No significant alterations will be carried out to the banks of the River Nore.
4.7	The following measures will be put in place during construction to reduce or eliminate pollution of rivers with substances associated with the construction phase: • Raw or uncured waste concrete will be removed from the construction site and disposed of in accordance with the relevant Waste Management Legislation. • Wash down water from concrete trucks, cast in place concrete, etc. will be collected in a suitable containment structure and then taken off-site to an appropriate facility for treatment and/or disposal. • Fuels, lubricants and hydraulic fluids for equipment used in the construction site will be carefully handled to avoid spillage, properly secured against unauthorised access or vandalism, and provided with spill containment according to current best practice (Enterprise Ireland BPGCS005). • Fuelling and lubrication of equipment will be carried out in bunded areas. • Appropriate spill control equipment will be kept within the construction site in the event of an emergency. • Any spillage of fuels, lubricants or hydraulic oils will be immediately contained and the contaminated soil removed from the construction site and disposed of in accordance with all relevant Waste Management Legislation. • No vehicle or equipment maintenance work will take place within the construction site. • Prior to any in-stream work commencing all construction equipment will be checked to ensure that they are mechanically sound, to avoid leaks of oil, fuel, hydraulic fuels and

	grease. • All pumps using fuel or containing oil will be locally and securely bunded when situated within 25m of waters or when sited such that, taking account of gradient and ground conditions, there is the possibility of discharge to waters. • Foul drainage from offices etc. within the construction site will be removed to a suitable treatment facility. • Measures will be implemented to minimise waste and ensure correct handling, storage and disposal of waste (e.g. concrete asphalt). • Emergency response procedures will be put in place.
4.8	For an construction work within or directly adjacent to surface waters the following mitigation measures also apply: • Ready-mix suppliers will be used in preference to on-site batching. • Hydrophilic grout and quick-setting or rapid hardener additives will be used, to promote the early set of concrete surface exposed to water. • Where concrete is to be placed under water it will be designed to provide a cohesive mix to limit segregation and washout of fine material. This will be achieved by having either a higher than normal fines content, a higher cement content or the use of chemical admixtures with low toxicity to aquatic life. • The pH of all discharges made from and during construction work shall be in the range 6.0 – 9.0 units, and shall not alter the pH of any receiving fisheries waters by more than +/- 0.5 pH units (SRB 2007).
4.9	The main construction compound will be located at least 50m from the nearest watercourse. In general, any other sites for use as storage areas, machinery depots and site offices will not be located within 50m of the nearest watercourse.
4.10	If necessary, water abstraction for dust suppression will only take place at locations, in a manner, and during a time period agreed with the IFI.
4.11	A 'closed' drainage system will be installed for the Scheme which will prevent significant pollution entering receiving waters. There will be two outfalls to the River Nore, one on the east and one on the west side of the river. Oil and grit interceptors will be located at carriageway level to remove oil and sediment from the run-off. Design of those interceptors will conform to the recommendations of CIRIA Report No. 142 – Control of Pollution from Highway Drainage Discharges. The drainage system will have a proven capability of achieving and sustaining at least the following percentage pollution reduction in run-off entering receiving watercourses: Total suspended solids – 85% Heavy metals – 50-80%

	Chemical Oxygen Demand – 50% Hydrocarbons – 90%

15.5 Hydrology, Soils, Geology and Hydrogeology – Chapter 8.0 and Chapter 9.0

Number	Geology, Hydrology and Hydrogeology Commitments
	As well as the mitigation measures outlined below, those measures already outlined in Table 15.4 above are equally applicable to the protection of geology, hydrology and hydrogeology. Furthermore, the implementation of a comprehensive EOP will ensure good construction management practices and appropriate handling and spill response procedures are followed as part of the implementation of the Mitigation Strategy.
5.1	If contaminated soil is encountered in any areas during construction, the extent of the contamination will be established. If necessary, it will be removed off-site and disposed of in accordance with the requirements of all relevant Waste Management Legislation and guidance provided in the NRA document entitled 'Guidelines for the Management of Waste from National Road Construction Projects, 2008'.
5.2	Local amenity groups that use the River Nore will be informed in advance of the construction period so as to minimise disruption during construction.

15.6 Air Quality and Climate – Chapter 10.0

Number	Air Quality and Climate Commitments
6.1	A dust minimisation plan will be developed by the contractor and will be included in the EOP as part of the Mitigation Strategy. The Plan will serve to minimise any impacts on sensitive receptors and designated areas. The following measures will be implemented: • Controlled spraying of exposed earthworks activities with water during dry weather; • Control of vehicle speeds and speed restrictions; • Sweeping of hard surface roads; and, • Provision of hoarding where works occur adjacent to sensitive receptors or designated areas.

15.7 Noise and Vibration – Chapter 11.0

Number	Noise and Vibration Commitments
7.1	The construction noise limits recommended by the NRA as outlined in Table 10.2 of Chapter 10 of this EIS will be adhered to.
7.2	BS 5228 (2009) Code of Practice for Noise and Vibration Control on Construction and Open Sites: Part 1: Noise contains guidelines and recommendations which are

	considered appropriate and good working practice for all construction contracts, as do the NRA Guidelines and the NRA Guidelines for the Creation, Implementation and Maintenance of an Environmental Operating Plan. The contractor will use these documents as a guideline for the prevention of noise impacts at sensitive receptors during the construction of the Scheme. The EOP which will be prepared as part of the Mitigation Strategy will outline in detail the noise mitigation measures which will be put in place by the contractor and will include measures 7.3 – 7.19 below.
7.3	Consultation will be required with the Local Authority in relation to construction activities at certain times.
7.4	A public awareness strategy will be established to promote awareness of measures being taken to restrict noise and vibration to acceptable levels.
7.5	A responsible person will be appointed on-site to deal with public queries and complaints. Residents will be informed of the time, duration and location of noisy work.
7.6	An on-site documented complaints procedure will be implemented.
7.7	Working hours will be agreed between the contractor and the Local Authority in advance. If activities outside normal working hours are required, such equipment will be sited and enclosed to ensure that noise levels do not exceed 45dB $L_{Aeq,5mins}$ and an L_{Amax} value of 69dB outdoors at a distance of 1m from the facade of the nearest noise sensitive receptor.
7.8	Piling activities will be designed to have as low noise emissions as possible at sensitive locations.
7.9	Sensitive receptors in close proximity to piling operations will be made aware of the timing of the work and the reasons for the work, in advance of piling taking place.
7.10	The contractor will implement the control measures for relevant plant listed in BS 228 and apply the appropriate measures.
7.11	Plant will be properly and regularly maintained, and if not it will be replaced.
7.12	Compressors used will be ‘sound reduced’ models fitted with properly lined and sealed acoustic covers which will be kept closed whenever machines are in use and all ancillary pneumatic tools will be fitted with suitable silencers.
7.13	Machinery, which is use intermittently, will be shut down or throttled back to a minimum during those periods when it is not in use.
7.14	All vehicles and mechanical plant to be fitted with effective exhaust silencers.
7.15	Plant known to emit noise strongly in one direction will, when possible, be orientated so that the noise is directed away from noise sensitive receptors.
7.16	Noise monitoring will be conducted during noisy or extensive works at locations close to

	noise sensitive receptors.
7.17	A low noise road surface which will give an average noise reduction of 3dB in comparison with a bituminous surface will be put in place along the length of the Scheme.

15.8 Landscape and Visual – Chapter 12.0

Number	Landscape and Visual Commitments
8.1	The area to be taken for the construction of the Scheme will be the minimum necessary at sensitive locations, particularly in the vicinity of the River Nore; and in the area of the cSAC.
8.2	Trees will be removed only where necessary. A site specific tree survey will be carried out in advance of construction, and will include appropriate work method statements and tree retention and protection proposals. The pre-construction tree survey will be repeated at the end of the construction works and any necessary remedial tree-works to ensure the safe retention of the trees will be completed by the end of the works.
8.3	Trees to be retained will be adequately protected, and, where possible, will be protected in line with the provisions of BS 5837 Trees in relation to Construction.
8.4	Site lighting will be the minimum required for the safe operation of the works, will be directed towards the works and horizontal cut-off light fittings will be used to prevent light spill outside of the site.
8.5	Site compounds will avoid impacting on areas outside of the Scheme construction area.
8.6	Good working practices will be established through the implementation of the EOP as part of the mitigation strategy.
8.7	Horizontal cut-off lighting will be use on the proposed River Nore bridge.
8.8	Where private gateways, boundaries or walls are disturbed or removed, an appropriate boundary treatment will be provided at the line of the proposed land-take, or elsewhere, in agreement with the land owner, if appropriate.

15.9 Cultural Heritage – Chapter 13.0

Number	Cultural Heritage Commitments
9.1	Where possible, all archaeological sites and their environs will be avoided in order to minimise the impact on the archaeology of the study area.
9.2	Archaeological investigative excavation, in the form of controlled test trenching will be carried out, in those areas identified by the Scheme archaeologist, under license in accordance with Section 26 of the National Monuments Act 1930, and with a method statement agreed in advance with the DoEHLG. The investigation report will include

	mitigation proposals for dealing with the discovery of archaeological deposits and material during development.
9.3	Archaeological monitoring of all bankside impacts relating to the construction of the proposed River Nore bridge will be undertaken in advance of construction works taking place. The archaeological monitoring should be undertaken by a suitably qualified archaeologist with previous experience of riverine archaeology.
9.4	Any architectural fragments from the medieval and post-medieval period, deemed worthy of salvage by the monitoring and/or investigative archaeologist, will be retained for potential reinstatement within appropriately development(s) within the City.
9.5	Archaeological monitoring will take place during all ground and demolition works including soil stripped of all ground areas associated with the Scheme and any associated roadworks, drainage works etc., with the provision for full excavation of any archaeologically significant material uncovered at this time. This work will be done under licence in accordance with the National Monuments Acts 1930-2004, and with a Method Statement to be agreed in advance with the DoEHLG and the National Museum of Ireland.
9.6	In the event of archaeological features or material being uncovered during the construction phase, it is crucial that the machine work cease in this immediate area to allow the archaeologist(s) to inspect any such material. If it is established that archaeologically significant material is present, then full archaeological excavation and recording of such will take place.
9.7	Fencing of any areas of archaeological significance will be provided once discovered and during excavation works.
9.8	No site offices, depots, or storage facilities will be placed on or near any of the recorded sites. Machinery traffic during construction will be restricted so as t avoid any of the selected sites and their environs.

15.10 Material Assets – Chapter 14.0

Number	Material Assets Commitments
10.1	Compensation payments for lands to be acquired as a result of the Scheme will be agreed between the relevant landowners and Kilkenny County Council. Where part of a field is to be acquired replacement boundary treatment will be provided. Where access to a field is affected the access will be reinstated or an alternative access will be provided, in agreement with the relevant landowners. Where severance occurs an underpass will be provided.

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