8 AIR QUALITY & CLIMATE / NOISE & VIBRATION

This section of the Environmental Impact Assessment Report (EIAR) assesses both the air quality & climate and the likely noise & vibration impact of the proposed works, in the context of current relevant standards and guidance, and identifies any requirements or possibilities for mitigation which are detailed below.

The key issues examined in this section of the EIAR are air quality and climate, noise impact and vibration impact.

Construction activities such as excavation, material handling and operation of construction plant and machinery and can lead to emissions of pollutants such as sulphur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter ($PM_{2.5}$ & PM_{10}) and carbon monoxide (CO), all of which can impact on air quality and climate. The impact of the proposed Drainage Scheme on air quality and climate is presented in this section of the EIAR.

Noise and vibration impact assessments have been prepared for the proposed Scheme to the nearest noise sensitive locations (NSLs). The proposed works will not have noise and vibration impacts during the operational phase, therefore it is only considered necessary to assess the potential noise and vibration impact during the construction phase of the Scheme which will be short term in nature.

The River Deel (Crossmolina) Drainage Scheme has an indefinite operational duration, therefore it is not considered necessary to assess the impacts of decommissioning.

A description of the proposed works is provided in Chapter 3 of the EIAR.

8.1 METHODOLOGY

This Chapter has been compiled in accordance with the following:

- The European Commission 'Guidance on the Preparation of the Environmental Impact Assessment Report' (2017),
- The European Commission 'Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment' 2013
- The EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports' (DRAFT August 2017)
- The EPA 'Advice Notes on Current Practice in the preparation of Environmental Impact Statements'
- The Department of Housing's 'Guidelines for Planning Authorities and An Bord Pleanála on Carrying out Environmental Impact Assessment' (August 2018)

The Study Area referred to in this Chapter relates to the area within the Scheme temporary works boundary, as identified in Chapter 3, Figure 3.1.

A desktop study was carried out in order to ascertain a comprehensive baseline for the Study Area and give a description of the existing environment. This information was then used to assess the potential impacts and significant effects that the proposed Drainage Scheme will have on Air Quality, Climate, Noise and Vibration within the Study Area in accordance with the description of impacts set out in Chapter 1. Where impacts are identified, mitigation measures are set out to ensure that any potential impacts identified will not have a significant effect on the environment during the construction and operational phase.

8.2 AIR QUALITY STANDARDS AND CLIMATE AGREEMENTS

8.2.1 Ambient Air Quality Standards

National and European statutory bodies have set limit values for various air pollutants in order to reduce the risk to human health from poor air quality. These limit values or "Air Quality Standards" are health or environmental-based levels for which additional factors may be considered. Limit values are set out in the Tables 8.1 – 8.3.

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 (S.I. No. 180/2011), which incorporate European Union (EU) Directive 2008/50/EC which combines the previous air quality framework and subsequent daughter directives. Although the EU Air Quality Limit Values are the basis of legislation, other thresholds outlined by the EU Directives are used which are triggers for particular actions (see Tables 8.1 – 8.3).

There are no statutory guidelines regarding the maximum dust deposition levels that may be generated during the construction phase of a development in Ireland. Furthermore, no specific criteria have been set in respect of this development. However, guidelines from the Department of the Environment, Heritage and Local Government currently exist for dust emissions from quarrying and ancillary activities (DEHLG, 2004). These can be implemented with regard to dust emissions from the proposed construction sites.

With regard to dust deposition, the German TA-Luft standard for dust deposition (non-hazardous dust) (German VDI, 2002) sets a maximum permissible level for dust deposition of 350 mg/(m^2*day) averaged over a one year period at any receptors outside the site boundary. Recommendations outlined by the Department of the Environment, Health & Local Government, apply the Bergerhoff limit of 350 mg/(m^2*day) to the site boundary of quarries (DOEHLG, 2004).

The concern from a health perspective is focused on particles of dust which are less than 10 microns. EU ambient air quality standards (Council Directive 2008/50/EC transposed into Irish law as S.I. 180 of 2011) centres on PM_{10} (particles less than 10 microns) as it is these particles which have the potential to be inhaled into the lungs and cause some adverse health impact. The Directive also sets an ambient standard for $PM_{2.5}$ (particles less than 2.5 microns) which came into force in 2015.

The European Environment Agency report *Air Quality in Europe – 2019* indicated that in 2016, 1,180 deaths in Ireland were attributed to exposure to pollutants including fine particulate matter ($PM_{2.5}$), nitrogen oxides (NOx) and Ozone (O_3).

Pollutant	Regulation Note 1	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/m³ NO_2
		Annual limit for protection of human health	40% until 2003 reducing linearly to 0% by 2010	40 µg/m³ NO_2
		Annual limit for protection of vegetation	None	30 µg/m³ NO + NO_2
Lead	2008/50/EC	Annual limit for protection of human health	100%	0.5 µg/m³
Sulphur dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	150 µg/m³	350 µg/m³
		Daily limit for protection of human health - not to be exceeded more than 3 times/year	None	125 µg/m³
		Annual & Winter limit for the protection of ecosystems	None	20 µg/m³
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/m³ PM_{10}
		Annual limit for protection of human health	20%	40 µg/m³ 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/m³ $PM_{2.5}$
$PM_{2.5}$ (Stage 2)Note 2	-	Annual limit for protection of human health	None	20 µg/m³ $PM_{2.5}$
Benzene	2008/50/EC	Annual limit for protection of human health	100% until 2006 reducing linearly to 0% by 2010	5 µg/m³
Carbon Monoxide	2008/50/EC	8-hour limit (on a rolling basis) for protection of human health	60%	10 mg/m³ (8.6 ppm)

Table 8.1 Air Quality Standards Regulations 2011 (Based on Directive 2008/50/EC and S.I. 180 of 2011)

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'.

Pollutant	Averaging Period	Primary & Secondary Standard Note 1 (μg/m3)	PSD Increment Class II Note2 (μg/m3)
PM_{10}	Annual – Average over 3 years	50	17
	24-Hour – as a 99th%ile over 3 years	150	30
NO_2	Annual Mean	100	25
CO	8-Hour – 3-year average of annual 4th highest daily maximum 8-hour conc.	10,000	-
	1-Hour – not to be exceeded more than 3 times in 3 consecutive years	40,000	-
Hydrocarbon (Benzene)	3 Hours (6-9 AM) (corrected for methane)	160	-

Table 8.2 US National Ambient Air Quality Standards (NAAQS) & PSD Increments

Note 1 Primary standards to protect public health whilst secondary standards are set to protect public welfare

Note 2 Class I areas are national parks and similar areas. Class II are all areas not originally classified as Class I.

Substances	Time-weighted Average	Averaging Time
Lead	0.5-1.0 μg/m³	1 year
Nitrogen dioxide	200 μg/m³ 40μg/m³	1 hour annual
Sulphur Dioxide	500 μg/m³ 20μg/m³	10 minutes 24 hour
Carbon monoxide	100 μg/m³ 60 μg/m³ 30 μg/m³ 10 μg/m³	15 minutes 30 minutes 1 hour 8 hour
Ozone (O3)	100 μg/m³	8 hour
Benzene	Note 1	
Particulate matter ($PM_{2.5}$)	25 μg/m³ 10μg/m³	24 hour annual
Particulate matter (PM_{10})	50 μg/m³ 20μg/m³	24 hour annual

Table 8.3 WHO Air Quality Guidelines 1999 & 2005

Note 1 No safe level recommended owing to carcinogenicity.

8.2.2 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, 1997 & 1999). The Paris Agreement (2015) replaced the Kyoto Protocol and aims to strengthen the global response to the threat of climate changes. The Paris Agreement puts in place the necessary framework for all countries to take ambitious mitigation action. It aims to tackle 95% of global emissions through 188 Nationally Determined Contributions (NDCs). The agreement also places significant importance on actions needed, both nationally and globally, to help people adapt to climate change. Ireland will contribute to the mitigation aspects of the Agreement via the NDC tabled by the EU on behalf of Member States which commits to a 40% reduction in EU-wide emissions by 2030 compared to 1990. The most recent Conference of the Parties (COP25) to the agreement was convened in Madrid, Spain in December 2019.

The policy framework for actions in Ireland follow the National Policy Positions (Department of Environment, Climate, and Local Government, 2014) and the Climate Action and Low Carbon Development Act, 2015 and specify the short-term actions and longer-term strategies to advance mitigation and adaptation of these framework of actions.

Furthermore, two options were identified in the 'Environmental Protection Agency, An Assessment: Ireland's Environment' (2016) in order to respond to the challenges posed by climate change. These options are the mitigation of emissions of Greenhouse Gases (GHGs) that are driving climate change and the adaptation to reduce vulnerability to the adverse impact of climate change.

Ireland's emission should follow a trajectory where an attempt is made to reduce emissions of GHGs to near or below zero as per the National Policy Statement (DECL, 2014). Mitigation and adaptation actions are framed and informed by United Nations (UN), EU, and national policy. These include:

- UN Framework Convention on Climate Change (UNFCCC)
- Kyoto Protocol
- UN Paris Agreement
- EU Climate and Energy Package
- National Climate Change Adaptation Framework (2012)
- National Policy Position on Climate Change and Low Carbon Development (2014)
- Climate Action and Low Carbon Development Act 2015
- National Mitigation Plan (2017)
- National Adaptation Framework (2018)
- Climate Action Plan (2019)
- Directive 2001/42/EC
- Council Directive 2003/87/EC
- EU Effort Sharing Decision (Decision no. 406/2009/EU)

The National Policy Position (2014) set out a commitment to decarbonisation of the economy by 2050 and the Climate Action and Low Carbon Development Act 2015 provides a statutory framework for it. The National Mitigation Plan (2017) is a strategic approach to address the climate challenge in Ireland and globally in order to transition into a low-carbon and climate resilient nation and is a step towards decarbonisation. The National Adaptation Framework (2018), sets out a strategy for the application of climate change adaptation measures in different sectors and by local authorities. The aim is to reduce the vulnerability of the State to the potential impacts of climate change and aid in assessing the risk and vulnerabilities of climate change, implement resilience actions, and ensure consideration to climate adaptation in streamlined into policy making (Department of Communications, Climate Action, and Environment, 2018).

Climate change could potentially impact various sectors in Ireland such as agriculture, the marine environment, biodiversity, coastal/riparian zones, critical infrastructure, water management, and human health and well-being. Impacts on these sectors may result from changes in air and soil temperatures, changes in rainfall patterns and extreme events, shift in climate and temperatures (EPA, 2016).

8.3 AIR QUALITY & CLIMATE - EXISTING ENVIRONMENT

8.3.1 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 significant variations in pollutant levels under the same source strength (i.e. traffic levels) (World Health Organisation, 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 stations collating detailed weather windrose records are Belmullet and Claremorris, which are located approximately 40 km northwest and 50km southeast of the Crossmolina Town, respectively. Data collated by Met Eireann for the 30-year average (1961 – 1990) indicates that the mean windspeed at Belmullet and Claremorris weather stations are 13.1 knots and 8.8 knots, respectively. The predominant wind direction is south to westerly.

In addition, records for Knock Airport weather station, located 40km southeast of Crossmolina, indicate a mean windspeed at Knock Airport is 9.5 knots for the period 1997 – 2019, with a predominant wind direction of south to westerly.

Based on the above, the mean windspeed at Crossmolina is likely to be in the region of 8.8 – 13.1 knots.

8.3.2 Available Background Data

Air quality monitoring programs have been undertaken in recent years by the EPA and Local Authorities. The National Ambient Air Quality Network is a series of air quality monitoring stations across the country.

Air quality data from the stations is assessed against the European legal limit values and World Health Organisation (WHO) guideline values, as detailed in Section 8.2.1.

The most recent annual report on air quality "*Air Quality in Ireland 2018*" (EPA, 2019), details the range and scope of monitoring undertaken as part of the National Ambient Monitoring Programme (AAMP) which commenced at the end of 2017. The report concluded that, based on the ambient air quality monitoring carried out by the EPA in 2018, air quality in Ireland was within the statutory limit and target values. Levels above the more stringent WHO guideline values were observed for particulate matter (PM_{10} and PM_{25}), ozone and NO_2.

The Clean Air For Europe Directive (Directive 2008/50/EC on ambient air quality and cleaner air for Europe) quires that areas are divided into zones for the assessment and management of air quality. In Ireland, Zone A is the Dublin Conurbation, Zone B is the Cork Conurbation, Zone C is all large towns in Ireland with a population >15,000 and Zone D is all remaining area. Crossmolina is categorised as Zone D.

Nitrogen Dioxide (NO_2)

The operation of construction plant and machinery has the potential to produce oxides of nitrogen (NOx). Nitrogen dioxide (NO_2) is of most concern due to its impact on health.

NO_2 monitoring is carried out at seventeen stations in Ireland in 2018. No exceedances of the EU annual limit value (40 µg/m^3) were recorded. Furthermore, monitoring of NO_2 levels in Zone D locations which was carried out by the EPA from 2007 to 2017 indicates that levels were consistently below the EU annual limit and WHO guideline values for NO_2 (EPA, 2018).

In 2013, NO_2 monitoring was carried out at the two rural Zone D locations, Emo and Kilkitt. The NO_2 annual mean for the sites was 4.1 and 3.0 µg/m^3 respectively. The results of NO_2 monitoring carried out at the urban Zone D location in Castlebar and Enniscorthy in 2016 indicated an average NO_2 concentration of 9.6 and 8.5µg/m^3 respectively while the Zone C locations of Kilkenny Seville Lodge and Portlaoise had average NO_2 concentrations of 6.5 and 11.1 µg/m^3 respectively with no exceedances of the 1-hour limit value (EPA, 2017). Hence 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 and baseline EPA monitoring data, an expected background concentration for Crossmonlina is similar to other Zone D NO_2 concentrations of between 3.0 and 9.6µg/m^3 which is well below the limit value of 40µg/m^3 for the protection of human health, and, 30µg/m^3 for the protection of vegetation.

Particulate Matter (PM_{10})

PM_{10} is generated on construction sites during activities such as excavation, handling and stockpiling of soil and aggregates and from cutting of materials.

PM_{10} monitoring was carried out at 26 monitoring stations in Ireland in 2018. No exceedance of the EU limit values (annual and daily) were recorded. Furthermore, monitoring of PM_{10} levels in Zone D locations which was carried out by the EPA from 2007 to 2017 indicates that levels were consistently below the EU annual limit and WHO guideline values for PM_{10} (EPA, 2018).

PM_{10} monitoring was carried out at the urban Zone D locations of Castlebar, Claremorris and Enniscorthy in 2016. The PM_{10} annual averages for the locations in 2016 were 11.9, 10.1 and 17.3 µg/m^3 respectively

(EPA, 2017). The PM_{10} annual average in 2016 for the rural Zone D location of Kilkitt was 8.1 µg/m^3. In addition, data from Rathmines provides a good indication of urban background levels, with an annual average in 2016 of 14.8 µg/m^3 (EPA, 2017). Based on the above information, a conservative estimate of the background PM_{10} concentration for Crossmolina is between 8.1 and 14.8 µg/m^3 which is below the annual mean limit values for human health of 40µg/m^3.

Fine Particulate Matter ($PM_{2.5}$)

Fine Particulate Matter is also is generated from construction activities such as excavation, handling and stockpiling of soil and aggregates and from cutting of materials.

$PM_{2.5}$ monitoring was carried out at 20 monitoring stations in Ireland in 2018. No exceedance of the EU limit values (annual and daily) were recorded. $PM_{2.5}$ monitoring for Zone D locations carried out by the EPA from 2007 to 2017 indicates that levels were consistently below the EU annual limit values for $PM_{2.5}$ (EPA, 2018). Based on this information, the anticipated background $PM_{2.5}$ concentration for Crossmolina is below the annual mean limit value for human health of 20 µg/m^3.

A study by the UK ODPM (2000) gives estimates of likely dust deposition levels in specific types of environments. In open country a level of 39 mg/(m^2/day) is typical, rising to 59 mg/(m^2/day) on the outskirts of town and peaking at 127 mg/(m$^{2/}$day) for a purely industrial area. As a worst-case, a level of 127 mg/(m^2*day) can be estimated as the existing dust deposition level for the current location which is below the TA Luft guidelines of 350 mg/m^2/day.

Benzene (C_6H_6)

Benzene emissions from the construction of the Scheme may arise from exhaust emissions and evaporation losses from construction machinery, and evaporation losses during the handling, distribution and storage of petrol.

With regard to benzene, continuous monitoring was carried out at Kilkenny Seville Lodge (Zone C), and Rathmines (Zone A) in 2016, with annual averages of 1.01 µg/m^3 and 0.2 µg/m^3 respectively (EPA, 2017). Monitoring of Benzene in Dublin, Cork and Kilkenny from 2007 – 2017 indicates that levels were consistently below the EU limit value over the time period (EPA, 2018).

Based on the above information a conservative estimate of the background benzene concentration for the region of the proposed development is below 1.0 µg/m^3. This is below the annual limit for protection of human health of 5 µg/m^3.

Carbon Monoxide (CO)

Carmon monoxide emissions from the construction of the Scheme may arise from exhaust emissions from construction plant.

In terms of CO, results for the Zone C location of Portlaoise was 0.4mg/m^3 annual mean for the rolling 8-hour CO concentration in 2016, while Enniscorthy (Zone D) was 0.06 mg/m^3 for the annual average. Monitoring of CO in Dublin and Cork from 2007 – 2017 indicates that levels were consistently below the EU limit value and WHO guideline value have been recorded over the time period (EPA, 2018).

The maximum 8-hour limit value for the protection of human health is set at 10 mg/m^3 (EPA,2017). Based on the above information a conservative estimate of the background CO concentration for the region of the proposed development is below 0.4 mg/m^3.

In summary, existing baseline levels of NO_2, PM_{10}, $PM_{2.5}$, CO and benzene based on extensive long-term data from the EPA are likely to be below ambient air quality limit values in the vicinity of the proposed development.

8.4 AIR QUALITY AND CLIMATE IMPACT ASSESSMENT

8.4.1 'Do Nothing' Scenario

If the proposed Scheme were not to proceed, there would be no additional dust or exhaust emissions due to the construction of a drainage Scheme. However, the opportunity to mitigate against flooding and the proposed Scheme's capacity to adapt to the impacts of climate change would be lost.

8.4.2 Air Quality – Dust Generation

Potential Short Term Slight Negative Impact

Construction activities may lead to the emission of dust. Dust is classified as matter with a particle size of between 1 and 75 microns (1-75 µm). As dust particles fall out of suspension in the air, dust deposition typically occurs in close proximity to the site and potential impacts generally occur within 500 metres of the dust generating activity. Deposition rates decrease with distance from the generating source and larger particles deposit closer to the source. Sensitivity to dust depends on the duration of the dust deposition, the dust generating activity, and the nature of the deposit. Therefore, a higher tolerance of dust deposition is likely to be shown if only short periods of dust deposition are expected and the dust generating activity is expected to stop.

The potential for dust to be emitted will depend on the type of activity being carried out in conjunction with environmental factors including levels of rainfall, wind speed and wind direction. Assuming worst case scenario, dust deposition may impact on properties within 500 m of the works during the construction phase of the Scheme. Dust generation rates depend on the site activity, particle size (in particular the silt content, defined as particles smaller than 75 microns in size), the moisture content of the material and weather conditions. Dust emissions are dramatically reduced where rainfall has occurred due to the cohesion created between dust particles and water and the removal of suspended dust from the air. It is typical to assume no dust is generated under "wet day" conditions where rainfall greater than 0.2 mm has fallen. 30-year average data (1961-1990) from Belmullet and Claremorris meteorological stations identified that typically 249 and 230 days per annum are "wet", respectively. Therefore, for greater than 63% of the time no significant dust generation will be likely due to meteorological conditions.

Large particles which are greater than 75 microns in size fall out of atmospheric suspension and are therefore deposited in close proximity to the source. Smaller particles which are less than 75 microns can remain in atmospheric suspension for a greater distance and therefore give rise to potential dust nuisance. Particles which are less than 75 microns in size are referred to as silt. Emission rates are normally predicted on a site-specific particle size distribution for each dust emission source.

The majority of dust produced during the construction period will be deposited in close proximity to the source and any impacts from dust will generally be within several hundred meters of the construction area (UK ODPM, 2000).

Construction activities such as excavating and earth moving are likely to produce some level of dust during the construction phase of the project. These activities will mainly produce particles of dust greater than 10 microns, these particles are considered a nuisance but do not have the potential to cause significant health impacts. As the construction phase of the scheme is short term, the potential for dust nuisance and significant levels of PM_{10} and $PM_{2.5}$ will be short term and will vary spatially during the construction phase, constituting a **short term slight negative impact**. Mitigation measures relating to dust generation are detailed below.

8.4.3 Air Quality – Exhaust Emissions

Potential Short Term Slight Negative Impact

Construction related traffic originating from the delivery of materials to the site, the removal of surplus excavated material from the site and the transport of workforce to, from and within the site will give rise to exhaust emissions within the site boundary (set out in Chapter 3) and along the anticipated transport routes presented in Chapter 11 which may lead to an increase nitrogen dioxide, sulphur dioxide, benzene and carbon monoxide which has the potential to impact on health and the environment as discussed in section 8.2.1 and 8.3.2. Given that background levels of nitrogen dioxide, sulphur dioxide, benzene and carbon monoxide are likely to be below ambient air quality limit values as discussed in Section 8.3.2, and emissions will be short term in nature, this constitutes a potential **short term slight negative impact** in terms of air quality. Mitigation measures relating to exhaust emissions are detailed below.

8.4.4 Climate

Construction Phase

Potential Short Term Negligible - Temporary Significant Negative Impact

Construction traffic will give rise to CO_2 and N_2O emissions during the construction phase of the proposed development. As these emissions will only be associated with the construction phase of the development which will be ongoing for a period of 3-4 years, the impact will be short term in nature. As specified in Chapter 11, the estimated peak daily volume of construction traffic is 107/day. The increase in greenhouse gas emissions due to the proposed development will result in a **potential short term negligible impact.**

During construction, in the absence of mitigation, the risk of flooding of the diversion channel during construction and subsequent risk of sediment transport to surface waters from a flood event presents a **potential temporary significant negative impact** due to flooding as a result of climate change. Mitigation measures are presented in Section 8.4.5.

Operation Phase

Potential Permanent Significant Positive Impact

The proposed Scheme is highly adaptable to increasing flood risk due to climate change, given that flows in excess of Q100 are split between the River Deel and the diversion channel, with the majority diverted to the diversion channel. As a result, lands that are at risk of flooding due to climate change will benefit from the proposed Scheme and the associated environmental, health, social and economic impacts of flooding due to climate change will be mitigated. Lands that will benefit from the Scheme include Crossmolina Town and lands along the banks of the River Deel between the river flow control structure and Lough Conn as shown on drawings BL_01 and BL_02 (Appendix 3A). This constitutes a permanent significant positive impact during the operation phase of the Scheme.

8.4.5 Mitigation Measures – Air Quality & Climate

The generation of dust is dependent on the construction activity being carried out. Environmental factors such as rainfall, wind speed and wind direction will also affect dust emissions. A worst case scenario has been assumed in the assessment. In order to predict and reduce the volume of dust emissions pertaining to the construction phase of the proposed Scheme, dust control measures have been developed and are included in the Outline Construction Environmental Management Plan (OCEMP) (Appendix 3C). Any measures specified in the plan that are to be carried out by third parties will be contractual obligations.

A number of measures will be implements in order to minimise dust impact:

- All site roads within the construction works boundary shall be regularly inspected, cleaned and maintained during the construction phase. The construction works boundary is shown in Appendix 3A.
- Hard surface roads within the construction site boundary shall be swept to remove mud and aggregate materials from their surface.
- Any road that has the potential to give rise to dust emissions must be regularly inspected and watered during periods of dry and/or windy weather to minimise the movement of dust particles to the air and ensure that dust does not cause a nuisance.
- Speeds shall be restricted on hard surface roads and vehicles transporting materials with dust potential must ensure that the material is enclose or covered with tarpaulin at all times.
- The construction traffic routes identified in Chapter 11 (Material Assets), shall be regularly inspected for cleanliness and cleaned as necessary to minimise the movement of dust particles to the air, as detailed in the OCEMP.
- In the event of dust nuisance occurring outside the site boundary, movement of materials must be terminated immediately and procedures implements to rectify the problem.
- The dust emission plan shall be reviewed at regular intervals during the construction phase to ensure that best practice and procedures are in place to minimise dust emissions.
- All plant and materials shall be stored in dedicated areas on site.
- Stockpiling of excavated material will be minimised by coordinating excavation, spreading and removal of surplus material off site.

A number of mitigation measures will be implemented in relation to exhaust emissions and climate during the construction phase:

- Machinery will be switched off when not in use.
- All construction vehicles and plant will be maintained in good operational order.
- Aggregate materials used in construction shall be sourced locally where possible to reduce potential emissions.

The following mitigation measures will be implemented in relation to the risks associated with flooding during the construction phase of the Scheme:

- Works will be sequenced, and temporary works areas have been selected to avoid potential for inundation of the works area by flood water in so far as is practicable during construction stage. The final section of the diversion channel to be constructed will be the section between the high point downstream of the L1105 bridge and the intake structure, thereby ensuring that the diversion channel will not become operational until the downstream extents of the channel have been fully reinstated.
- Works on the intake structure and river flow control structure will be carried out at times of good weather and low flow in the river where there is no potential for significant volumes of surface water runoff from the works area or inundation with flood waters.
- There will be no storage of materials, machinery or soil in areas that are susceptible to flooding

8.4.6 Monitoring

The dust mitigation measures put in place will be strictly monitored and assessed throughout the construction phase to ensure their effectiveness as identified in the OCEMP (Appendix 3C).

Dust monitoring shall be carried out as follows:

- Daily inspections shall be carried out to monitor dust within and in the vicinity of the Study Area, including roads. Monitoring shall include regular dust soiling checks of surfaces within 100 m of the site boundary.
- Regular site inspections shall be carried out in order to ensure that the dust control measures are being implemented effectively.
- The frequency of site inspections shall be increased when activities with a high potential to produce dust are being carried out (e.g. excavation and earth moving) or during prolonged dry or windy conditions.
- Dust deposition, dust flux or PM_{10} monitoring locations shall be agreed with the Local Authority. Baseline monitoring shall be carried out a minimum of 3 months in advance of works commencing on site.
- Inspection results shall be recorded and made available to the Local Authority on request.

8.4.7 Residual Impact – Air Quality and Climate

Short Term Negligible Impact and Permanent Significant Positive Impact

The implementation of the mitigation measures set out above will minimise impacts associated with dust generation, emissions and flood risk during construction, therefore the proposed Scheme will have a **short-term negligible impact** on air quality and climate during the construction phase.

The proposed Scheme will have a **negligible impact** on air quality once operational.

The proposed Scheme is highly adaptable to increasing flood risk due to climate change. As a result, lands that are at risk of flooding due to climate change will benefit from the proposed Scheme and the subsequent impacts of flooding due to climate change will be mitigated. This constitutes a **permanent significant positive impact** during the operation phase of the Scheme.

8.5 NOISE AND VIBRATION

8.5.1 'Do Nothing' Scenario

If the proposed Scheme were not to proceed, the existing noise and vibration environment would remain unchanged.

8.5.2 Construction Noise Level Criteria

The vast majority of potential noise and vibration impacts of the proposed works on the surroundings will occur during the construction phase. As detailed in Section 8.5.4, seven properties have been identified as being within 35 m of the proposed works.

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. Local authorities normally control construction activities by imposing limits on the hours of operation and consider noise limits at their discretion.

In the absence of specific noise limits, appropriate criteria relating to permissible construction noise levels for a development of this type may be found in the National Roads Authority (NRA) publication Guidelines for the Treatment of Noise and Vibration in National Road Schemes (2004) which indicates the following criteria and hours of operation. The majority of the construction activity is expected to occur during the hours of 8 am and 6 pm.

Table 8.4 indicates the maximum permissible noise levels at the facade of dwellings during the construction period as recommended by the NRA (Now TII).

Days and Times	Noise Levels (dB re. $2x10^{-5}$ Pa)	
	$L_{Aeq(1hr)}$	L_{Amax}
Monday to Friday 07:00 to 19:00hrs	70	80
Monday to Friday 19:00 to 22:00hrs	60*	65*
Saturdays 08:00 to 16:30hrs	65	75
Sundays & Bank Holidays 08:00 to 16:30hrs	60*	65*

Table 8.4 Maximum permissible noise levels at the facade of dwellings during construction

*Note: Construction activity at these times, other than that required for emergency works, will normally require the explicit permission of the relevant local authority.

8.5.3 Construction Vibration Level Criteria

Any potential vibration impact associated with the proposed works on the surroundings will occur during the construction phase of the proposed Scheme. No vibration impacts will occur following construction.

Vibration standards are divided into two varieties: those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. In both instances, the magnitude of vibration is considered in terms of Peak Particle Velocity (PPV).

Humans are particularly sensitive to vibration stimuli and any perception of vibration may lead to concern. In the case of road traffic, vibration greater than 0.5mm/s may be disturbing. Higher levels of vibration are typically tolerated for events of short duration or single events.

The following documents contain guidance in relation to acceptable vibration within buildings:

- British Standard BS 7385 - 2 (1993): *Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration*, and;
- British Standard BS 5228 – 2 (2009): *Code of Practice for Noise and Vibration Control on Construction and Open Sites: Vibration.*

BS 7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15mm/s at low frequencies rising to 20mm/s at 15Hz and 50mm/s at 40Hz and above. These guidelines relate to relatively modern buildings and should be reduced to 50% or less for more critical buildings.

BS 5228 recommends that, for residential property and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e. non-structural) damage should be taken as a peak particle velocity of 15mm/s for transient vibration at frequencies below 15Hz and 20mm/s at frequencies above than 15Hz. Below these vibration magnitudes minor damage is unlikely, although where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is such that resonances are excited within structures the limits discussed above may need to be reduced by 50%.

NRA, 2004 details the permissible vibration levels during construction phase for national road schemes. These are listed in Table 8.5.

Allowable vibration (in terms of peak particle velocity) at the closest part of 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**

Table 8.5 Allowable Vibration During Construction Phase

It should be noted that these limits are not absolute but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage. Magnitudes of vibration slightly greater than those in the table are normally unlikely to cause cosmetic damage, but construction work creating such magnitudes should proceed with caution. Where there is existing damage, these limits may need to be reduced by up to 50%.

8.5.4 Noise Sensitive Receptors

Noise sensitive receptors were identified based on their proximity to the proposed works. The following diagrams / photos detail each of the adjacent noise sensitive receptors that have been identified and included in the assessment of noise impacts.

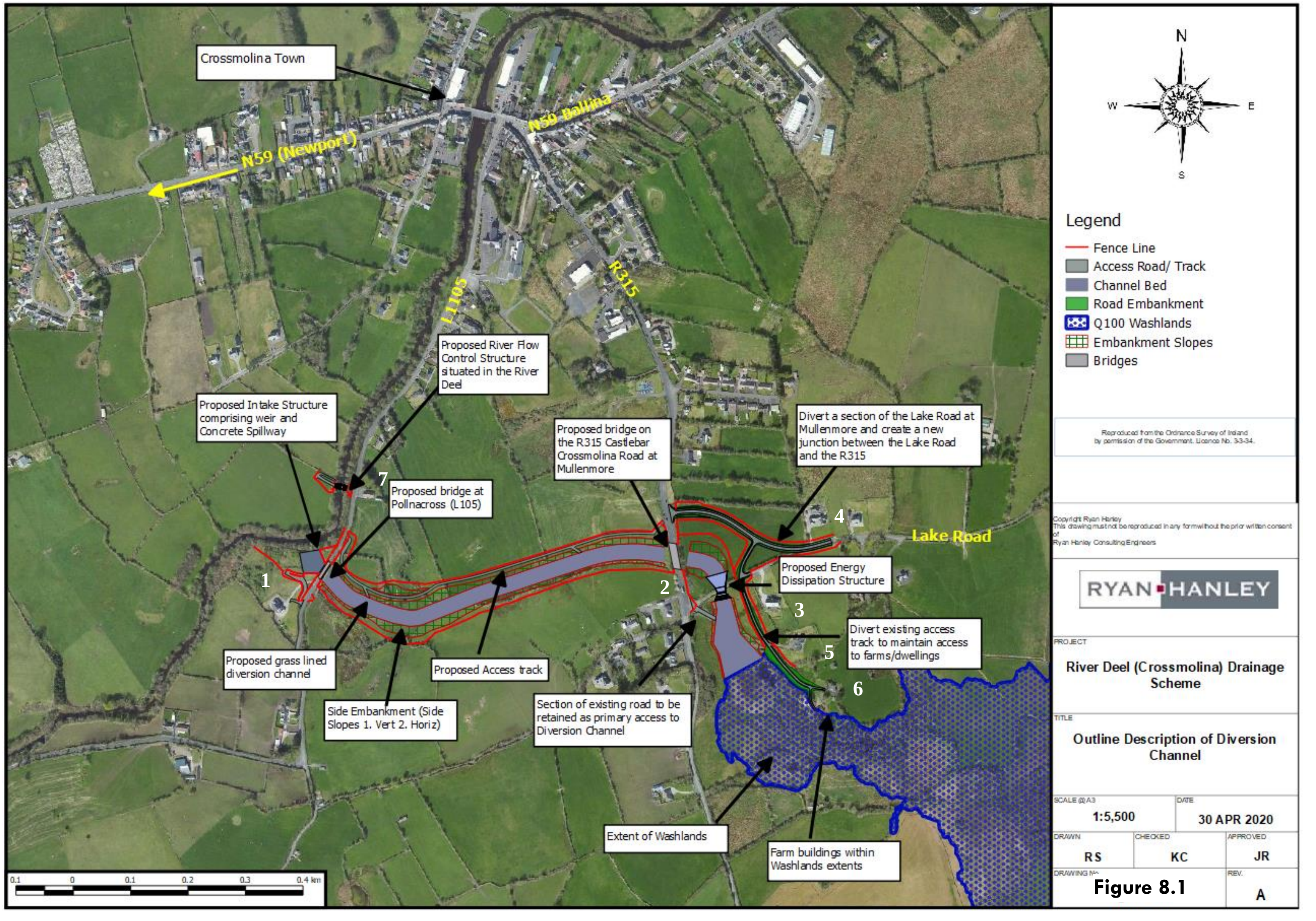
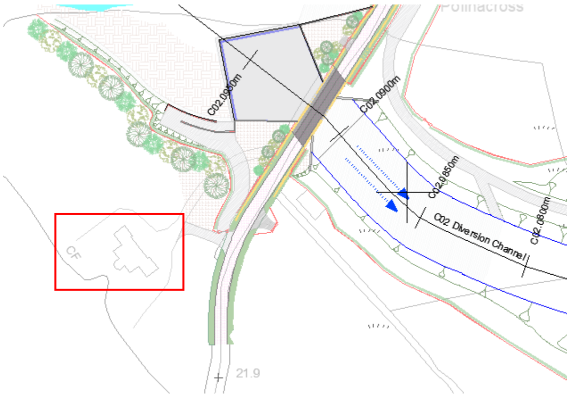
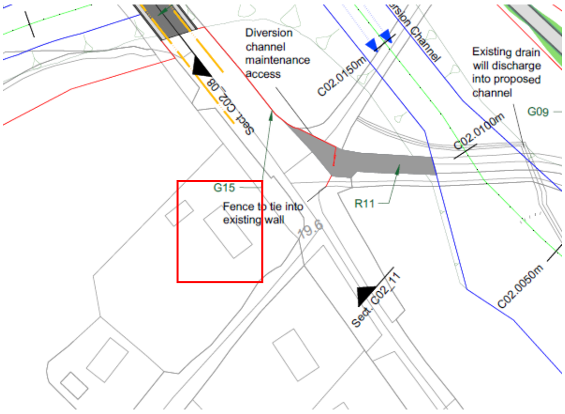


Figure 8.1 Noise Sensitive Location Map

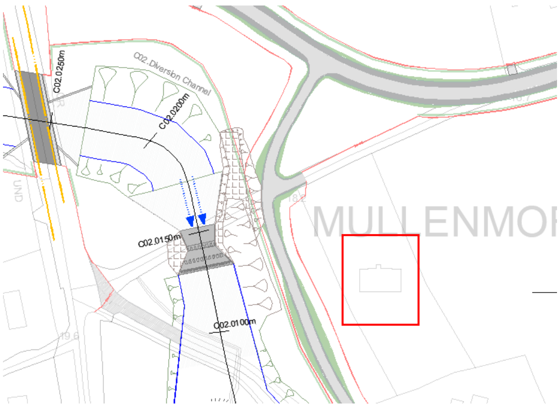
NSL 1



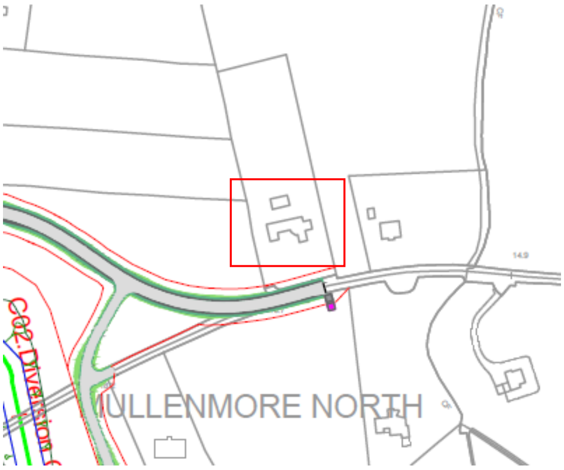
NSL 2:



NSL 3

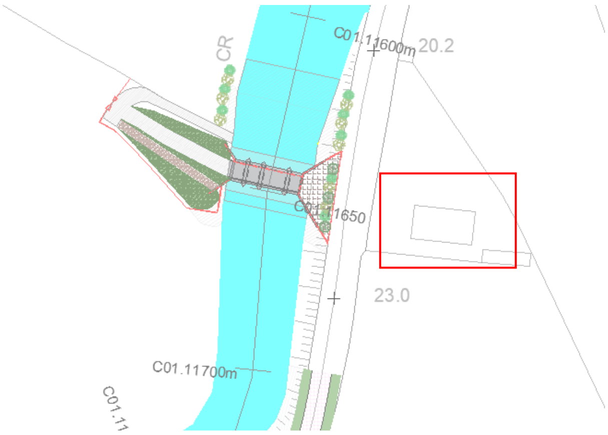


NSL 4



NSL 5 & 6

NSL 7



8.6 Noise Impact

Works associated with the proposed development that may contribute to noise impact are as follows:

- Construction of bridge and road infrastructure;
- Construction of new channel and associated infrastructure;
- HGV movements;
- Piling works.

A variety of items of plant will be in use for each of these work activities, such as excavators, lifting equipment, dumper trucks, compressors, piling rigs and generators. Sheet piling is expected to be the noisiest activity and the flow of vehicular traffic to, from and along the easement routes is also a potential source of noise and vibration.

Due to the fact that the construction programme has been established in outline form only, it is not possible to calculate the actual magnitude of noise emissions to the local environment. However, the following sections present calculations of indicative noise levels for typical noise sources associated with each of the identified activity types. A worst-case condition is assumed whereby the listed plant items are at the closest point to each of the noise sensitive locations. In each instance, source information was obtained from BS 5228: 2009: *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise* which sets out typical noise levels for items of construction plant.

Table 8.6 provides the approximate distance from the nearest works to Noise Sensitive Locations.

Location	Distance From Works
NSL 1	30m
NSL 2	35m
NSL 3	30m
NSL 4	25m
NSL 5	31m
NSL 6	10m
NSL 7	25m

Table 8.6 Distance from Works Noise Emission to Nearest NSLs

8.6.1 Reinforced Concrete Works, New Channel Works, and Road Realignment

Potential Short Term Moderate to Significant Impact

Concrete works will be required at the following locations:

- A reinforced concrete spillway at the intake structure enclosed on three sides by a reinforced concrete retaining wall.
- Reinforced concrete retained walls at the river flow control structure
- Both bridges at Mullenmore (R315) and Pollnacross (L1105)
- The energy dissipation structure
- Other locations, such as footpaths along the Lake Road and locations within the grass lined channel as set out in Appendix 3A.

The proposed channel will involve the excavation of c 160,000m^3 of naturally occurring Fluvioglacial and glacial tills, the majority of which will be transported off site. The channel will be grass lined with reinforcement proposed at a number of locations in order to prevent potential scouring.

The proposed works include the realignment of the existing Lake Road and the creation of a new junction with the R315. This will necessitate the permanent closure of a section of the existing road and realignment of the existing avenues connecting the Lake Road to properties to the South to suit the new layout. It will also be necessary to elevate the realigned property access avenues to prevent flooding of these access routes in the event of a flood.

The construction of the reinforced concrete walls, channel excavation and road construction are expected to be carried out in a traditional manner as set out in Chapter 3 (Description of Proposed Development). Excavation and disposal of material is the main activity associated with channel construction. This will be followed by other activities such as channel lining, fencing, etc.

Concrete structures will require excavation for foundations, blinding of formation, fixing of the reinforcement and placing of the formwork and concrete. Sheet piling may be required in some areas to provide a cut-off measure where there is a possibility of flood water passing underneath the foundation, however this is considered unlikely based on available geotechnical information. The impact of piling noise emission is dealt with in Section 8.6.3.

Road construction will include excavation to foundation level, installation of pipework for road drainage and other ducting required to facilitate installation of underground utilities, including placement of pipe bedding, surround, placing and compaction of backfill material, construction of concrete footpaths, including fixing of reinforcement, placing of formwork, placing of concrete, and stripping of formwork, construction of road including sub base, road base, base course and wearing course.

Table 8.7 lists the expected noise sources associated with these activities, their assumed noise levels and the predicted noise emission levels at each of the nearest noise sensitive locations. The expected noise levels were calculated based on typical plant sound pressure levels at 10 m, as detailed in British Standard BS 5228:2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise and the distance from each of the NSLs to the closest point of each element of the construction works.

Item Of Plant (BS5228 Ref.)	Noise Level At 10m	Predicted Noise Level at NSL Locations (dB $L_{Aeq,1hr}$)						
		1	2	3	4	5	6	7
Excavation Phase								
170kW Tracked Excavator (C.2.16)	75	65	64	65	67	65	75	67
170kW Wheeled Loader (C.2.28	76	66	65	66	68	66	76	68
Dumper (C.2.32)	74	64	63	64	66	64	74	66
Cumulative	n/a	*70*	*69*	*70*	***72***	*70*	***80***	***72***

Item Of Plant (BS5228 Ref.)	Noise Level At 10m	Predicted Noise Level at NSL Locations (dB $L_{Aeq,1hr}$)						
		1	2	3	4	5	6	7
Construction Phase								
Large Concrete Mixer (C.4.22)	76	66	65	59	68	54	49	68
Truck Mounted Concrete Pump + Boom Arm (C.4.30)	79	69	68	62	71	57	52	71
Poker Vibrator (C.4.33, concrete works only)	78	68	67	61	70	56	51	70
Roller (C.2.37, L1105 / R315 Bridge)	79	69	68	55	52	52	49	71
Roller (C.2.38, road)	73	63	62	63	65	63	73	65
4kVA Generator (D.7.49)	76	66	65	66	68	66	76	68
Cumulative	n/a	***75***	***74***	*70*	***76***	*69*	***78***	***77***

Table 8.7 Predicted Concrete , New Channel Works and Road Realignment Activity Noise Emission To Nearest NSLs

The calculated levels listed above are commensurate with a worst-case condition that would only occur during the short span of time, that the listed plant items are at the closest point to each of the noise sensitive locations and assuming that no screening is in place. The worst-case scenario is unlikely to occur routinely, if at all.

Based on the above assessment, three of the NSLs may be exposed to noise levels above 70 dB $L_{Aeq(1hr)}$ during excavation works and 5 NSLs may be exposed to noise levels above 70 dB $L_{Aeq(1hr)}$ during the construction phase.

The impact of reinforced concrete works, new channel works and road alignment on the local environment is therefore expected to be a short term moderate to significant impact assuming the worst case scenario.

8.6.2 HGV Movements

Potential Short Term Negligible Impact

The construction phase of the proposed scheme will give rise to additional traffic which may incur a noise impact on the adjacent noise sensitive locations. Construction traffic will access the construction site along the existing roads and temporary access routes shown on the scheme drawings in Appendix 3A.

The noise level associated with an event of short duration, such as a passing vehicle movement, may be expressed in terms of its Sound Exposure Level (L_{AX}). The Sound Exposure Level can be used to calculate the contribution of an event or series of events to the overall noise level in a given period.

The appropriate formula is given below:

$$L_{Aeq,T} = L_{AX} + 10\log_{10}(N) - 10\log_{10}(T) + 10\log_{10}(r_1/r_2)\text{dB}$$

where:

$L_{Aeq,T}$ is the equivalent continuous sound level over the time period T (in seconds);
L_{AX} is the "A-weighted" Sound Exposure Level of the event considered (dB);
N is the number of events over the course of time period T;
r_1 is the distance at which L_{AX} is expressed;
r_2 is the distance to the assessment location.

The mean value of Sound Exposure Level for truck moving at low to moderate speeds (i.e. 15 to 45km/hr) is in the order of 82dB L_{AX} at a distance of 5 metres from the vehicle. This figure is based on a series of measurements conducted under controlled conditions.

The project estimates consider a maximum of 107 HGV round trip movements per day while works are being carried out at each works location. Using the equation detailed above and taking into account the attenuation due to distance, the predicted noise levels at each of the noise sensitive locations (NSLs) are listed in Table 8.8.

Location	Distance From Roadway / Easement	HGV Sound Exposure Level at 5 metres (dB,L_{AX})	Predicted Noise Level (dB, $L_{Aeq,1hr}$)
NSL 1	25m	82	48
NSL 2	14m		51
NSL 3	30m		48
NSL 4	25m		48
NSL 5	31m		48
NSL 6	10m		52
NSL 7	12m		52

Table 8.8 Predicted Construction Traffic Noise Emission At Nearest NSLs

The predicted noise emission levels range between 48dB and 52dB $L_{Aeq,1hr}$ with 52dB $L_{Aeq,1hr}$ being the expected maximum at the any remaining noise sensitive locations along construction traffic routes that are located immediately adjacent to the road (i.e. 10m away). These predicted noise levels are within the minimum design criterion of 70dB $L_{Aeq(1hr)}$. Therefore, the impact of construction traffic on the local environment is expected to be a **short term negligible impact.**

8.6.3 Piling

Potential Temporary Moderate to Significant Negative Impact

Based on available geotechnical information and the design channel invert levels, it is anticipated that piled foundations will be required for the Mullenmore (R315) Bridge and the energy dissipation structure. These will consist of cast in situ bored reinforced concrete piles.

Sheet piling may be required in some areas to provide a cut-off measure where there is a possibility of flood water passing underneath the foundation, however this is considered unlikely, again based on available geotechnical information and the design channel invert levels.

The requirement for sheet piling will be determined following a detailed site investigation. Therefore, as part of this assessment and in order to demonstrate the worst-case scenario, piling is considered at the Mullenmore (R315) Bridge, the energy dissipation structure, the intake location and the river flow control structure.

Table 8.9 summarises the predicted noise levels due to piling activities at the nearest noise sensitive locations. The expected noise levels were calculated based on the plant sound pressure levels at 10 m, as detailed in British Standard BS 5228:2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise. No screening was included as part of the assessment.

Item Of Plant (BS5228 Ref.)	Noise Level At 10m	Predicted Noise Level at NSL Locations (dB $L_{Aeq,1hr}$)						
		1	2	3	4	5	6	7
Excavation Phase								
Mini piling Rig (C.3.17)	76	60	61	60	52	53	49	67
Vibratory Piling Rig (C.3.3)	88	72	73	72	64	65	61	79
Cumulative	n/a	***72***	***73***	***72***	*60*	*65*	*61*	***80***

Table 8.9 Typical Piling Noise Levels At Nearest Noise Sensitive Locations

Table 8.9 indicates that piling noise emissions would result in an exceedance of the design criteria at noise sensitive locations 1, 2, 3 and 7 assuming the worst case scenario piling will be required at the Mullenmore (R315) Bridge, the energy dissipation structure, the intake location and the river flow control structure, that normal piling methods are employed and that no screening is in place. Based on the assessment of worst case scenario, in the absence of mitigation, there will likely be a significant amount of noise at four of the noise sensitive locations (1,2,3 and 7) although it would be likely to occur over relatively short durations. Measures to mitigate against the noise impact are presented in Section 8.6.5.

8.6.4 Site Investigation

Potential Temporary Negligible Impact

Limited geotechnical ground truthing will be carried out on commencement of the construction stage of the Scheme which will involve some of the activities described above but are likely to occur over short durations and are expected to be very low scale in nature and therefore are considered negligible when compared with the predicted impacts of the proposed Scheme.

8.6.5 Mitigation Measures – Noise

In order to sufficiently ameliorate the likely noise impacts from the proposed works, a schedule of noise and vibration control measures has been formulated for the construction phase and are further detailed in the Outline Construction Environmental Management Plan (OCEMP) (Appendix 3C). Any measures to be carried out by third parties will be contractual obligations.

Reference will be made to BS 5228-1: 2009: *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise*, which offers detailed guidance on the control of noise & vibration from demolition and construction activities.

In particular, it is proposed that various practices be adopted during construction, including:

- where noise levels at NSLs are anticipated to exceed the daytime noise criteria, hoarding extending to a height of 2.4 m will be erected between the works area and the NSL. If such measures are installed, the construction operations are expected to meet or be less than the 70 dB $L_{Aeq(1hr)}$ criterion

- an alternative piling process which is viable to reduce noise and vibration impacts such as the Giken Seisakusho 'Silent Piler', or Variable Frequency Hammer or Variable Static Moment piling will be employed, if it is necessary to include sheet piling in the works. The Giken piling rig employs a 'press-in' method of piling in lieu of the more typical vibratory or impact type of piling. This method allows pre-formed piles to be installed with minimal noise and vibration generation. Noise level data for the Giken 'Silent Piler' indicates a measured sound pressure level of 75dB(A) at a distance of 1m (White et al, 2002). Assuming the piling rig operates continuously for one hour, this would result in a noise level of 65dB LAeq, 1hr at a distance of 10m, which would be a closer distance than the piling works would be to any noise sensitive location. This level would be within the established criteria at each location and, hence, would allow piling activities to occur at any of the proposed works locations without a significant risk of noise emission exceeding the criteria.
- limiting the hours during which site activities likely to create high levels of noise or vibration are permitted;
- establishing channels of communication between the contractor/developer, Local Authority and residents; inform affected residents of time of blasting or piling 24 hours in advance;
- appointing a site representative responsible for matters relating to noise;
- monitoring typical levels of noise during critical periods and at sensitive locations and along the river bed.

Furthermore, a variety of practicable noise control measures will be employed. These will include:

- selection of plant with low inherent potential for generation of noise;
- erection of enclosures as necessary around noisy processes and items such as generators, heavy mechanical plant or high duty compressors;
- placing of noisy plant as far away from sensitive properties as permitted by site constraints

8.6.6 Monitoring – Noise

During the proposed works, noise monitoring will be conducted during certain activities. It is considered that short term attended noise measurements would be appropriate to ensure that the project design criteria are being met. The ECoW in consultation with the Site Manager and an appointed Acoustic Consultant will define the critical periods, persons responsible for monitoring and the noise sensitive locations that will be monitored and is provided in Appendix 3C.

The following survey methodology will be employed for attended noise monitoring:

- measure LAeq, LAMax, LAMin, LA10 and LA90 over a sample period of 15 minutes;
- detailed notes will be taken in relation to primary noise sources, weather and prevailing winds;
- measurements will be conducted at various locations on a cyclical basis over the course of a typical day.

Noise monitoring will be conducted in accordance with ISO 1996: 2007: *Acoustics – Description, measurement and assessment of environmental noise.*

8.6.7 Residual Impact – Noise

Short Term Slight Negative Impact

During the construction phase of the project and with the above mitigation measures and monitoring in place, nearby residential properties will not be exposed to significant noise emissions from construction work given that they in most cases are over 20m from the works.

Given that the construction phase of the development is short term in nature and calculated levels with mitigation measures in place will meet or be less than the 70 dB criteria outlined in Table 8.4, it is expected that the various noise sources will be relatively slight. Furthermore, the application of binding noise limits and hours of operation, along with implementation of appropriate noise control measures such as screening will ensure that noise impact is kept to a minimum. The residual impact will be a **short term slight negative impact.**

8.7 VIBRATION IMPACT

Potential Temporary Moderate Negative Impact

The majority of the construction activities which will be employed during the construction phase of the proposed scheme with the exception of sheet piling are unlikely to generate perceptible vibrations at the sensitive noise locations. Piling activity is generally one of the most significant sources of vibration on construction sites.

Assuming worst-case scenario and the use of traditional piling methods, this will likely result in a **temporary negative impact** ranging in severity depending on the distance from the sensitive receptor to the works location. Therefore, assuming the worst-case scenario, there is likely to be a moderate amount of vibration impact although it would occur over relatively short durations.

8.7.1 Mitigation Measures – Vibration

In order to sufficiently ameliorate the likely vibration impacts from the proposed works, a schedule of noise and vibration control measures has been formulated for the construction phase and are further detailed in the Outline Construction Environmental Management Plan (OCEMP) (Appendix 3C). Any measures to be carried out by third parties will be contractual obligations.

Reference will be made to BS 5228-1: 2009: *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 2: Vibration*, which offers detailed guidance on the control of vibration from demolition and construction activities. In particular, the following practices will be adopted during construction:

- establishing channels of communication between the contractor/developer, Local Authority and residents; inform affected residents of time of blasting or piling 24 hours in advance;
- appointing a site representative responsible for matters relating to vibration;
- monitoring typical levels of vibration during critical periods and at sensitive locations and along the river bed.
- If traditional piling methods are employed, a test pile will be erected at the piling location closest to the nearest sensitive locations. Vibration monitoring will then be conducted to confirm that ground borne vibration will be within the guidance criteria limits listed in Table 8.5 and that no

structural damage will therefore occur to adjacent buildings. Vibration may also impact on aquatic species such as the fresh water pearl mussel. Vibration monitoring will also be conducted at locations along the river bed which are in proximity to piling activities in order to ensure that vibration will not adversely affect the aquatic environment. The vibration transmission associated with piling can be significantly reduced if piling operations are conducted using methods that are viable to reducing vibration impacts such as the 'press-in' method. Although the exact levels will depend on ground composition, research indicates that vibration levels at a distance of 10m from the piling rig would be of the order of 1mm/s (White et al. 2002). This level is well below the BS 5228 guidance criteria limits.

Furthermore, a variety of practicable vibration control measures will be employed. These will include:

- selection of plant with low inherent potential for generation of vibration;
- placing of vibratory plant as far away from sensitive properties as permitted by site constraints and the use of vibration isolated support structures where necessary.

Vibration from construction activities will be limited to the values set out in Table 8.5.

8.7.2 Monitoring – Vibration

During the proposed works, vibration monitoring will be conducted during certain activities. It is considered that short term attended vibration measurements would be appropriate to ensure that the project design criteria are being met. The ECoW in consultation with the Site Manager and an appointed Acoustic Consultant will define the critical periods, persons responsible for monitoring and the sensitive locations that will be monitored and is provided in Appendix 3C.

The following survey methodology will be employed for attended vibration monitoring or test pile measurements:

- measure the maximum ppv at each location over a sample period of 15 minutes;
- detailed notes will be taken in relation to primary vibration sources;
- measurements will be conducted at the locations on a cyclical basis over the course of a typical day (attended vibration monitoring only).

Vibration monitoring will be conducted in accordance with either BS 7385-1 (1990) *Evaluation and measurement for vibration in buildings — Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings* or BS 6841 (1987) *Guide to Measurement and Evaluation of Human Exposure to Whole-Body Mechanical Vibration and Repeated Shock* as appropriate.

8.7.3 Residual Impact – Vibration

Temporary Imperceptible Negative Impact

With the implementation of the above mitigation measures and monitoring and the use of piling methods that are viable to reducing vibration impacts such as the 'press-in' method at all piling locations, the likely impact of vibration from the proposed construction works on the local environment would not be significant.

8.8 CUMULATIVE AND IN-COMBINATION IMPACT ASSESSMENT

8.8.1 Cumulative Impact Assessment

All elements of the proposed Scheme were assessed in order to identify any cumulative effects.

Site activity during the construction phase could give rise to noise that could cause disturbance to fauna. All construction activities will be temporary in nature with limited interaction with the River Deel or other sensitive habitats and will progress across the works area of the entire Scheme, minimising the duration of works in any one area.

The excavation, movement and transport of soils, overburden and rock during the construction phase has the potential to give rise to noise and dust impacts. However, these effects and the measures that are in place to avoid any cumulative or interactive effects are fully described in this EIAR.

The movement of construction vehicles both within and to and from the site has the potential to give rise to noise and dust nuisance impacts during the construction phase. However, these effects and the measures that are in place to avoid any cumulative or interactive effects are fully described in this EIAR.

The operation of construction plant and machinery during the construction phase of the Scheme has the potential to give rise to emissions which can impact human health, air quality and climate. However, these effects and the measures that are in place to avoid any cumulative or interactive effects are fully described in this EIAR.

The proposed Scheme is highly adaptable to climate change and land that is at increased risk of flooding due to climate change will benefit from the proposed Scheme and the associated environmental, health, social and economic impacts of flooding due to climate change will be mitigated. The Scheme will therefore have a significant positive cumulative effect in relation to climate, human heath, water and material assets.

Based on the assessment of all elements of the proposed Scheme, no significant cumulative negative effects relating to air quality, noise and vibration are anticipated. A significant positive cumulative effect is anticipated in relation to the capability of the proposed Scheme in addressing flood risk associated with climate change.

8.8.2 In-Combination Impact Assessment

The potential cumulative effects on air quality, climate, noise and vibration between the proposed Scheme and other programmes and projects in the vicinity, as presented in Chapter 2, Section 2.8 of the EIAR, were also assessed.

Air Quality

The construction phase of the proposed Scheme, in combination with the construction phases of projects listed in Chapter 2, Section 2.8 above will have the potential to negatively impact on air quality of the area due to cumulative dust and construction plant emissions. The mitigation measures employed during the construction phase of the proposed Scheme will minimise the contribution that it will make towards impacting on air quality. Given that existing baseline levels of NO_2, PM_{10}, $PM_{2.5}$, CO and benzene are likely to be below ambient air quality limit values in the vicinity of the proposed Scheme, and with mitigation measures in place, there is the potential for a short-term negligible cumulative impact in terms of air quality.

Climate

The proposed Scheme, in combination with the projects listed in Chapter 2, Section 2.8 will have the potential to have a short-term imperceptible negative cumulative impact on climate as a result of vehicle emissions on any site during the construction phase. Overall, the proposed Scheme will constitute a permanent significant positive impact during the operation phase in combination with other projects in the vicinity, due to being highly adaptable to increasing flood risk due to climate change.

Noise & Vibration

In the unlikely event of all of the projects listed in Chapter 2, Section 2.8 above being constructed simultaneously, there is a potential for a short-term slight to moderate negative cumulative noise and vibration impact. The construction phase of the proposed Scheme will implement the mitigation measures listed in 8.6.5 and 8.7.1 above, thereby minimising the potential cumulative impact that this project could have. Any impacts from the proposed Scheme will most likely be temporary and transient in nature as the works progress along the route of the diversion channel. Impacts will also differ between receptors, depending on distance to the works areas, and the type of works being carried out in the area. Given the mitigation measures being implemented for this Scheme, and depending on the receptor in question, there is potential for no impact or a short-term imperceptible to slight negative cumulative impact.

Based on the assessment of the proposed Scheme in combination with all other programmes and projects in the vicinity, no significant in-combinate cumulative effects relating to air quality, climate, noise and vibration are anticipated.