Spink Quarry, Knockbaun, Abbeyleix, Co. Laois

Spink Quarry

Environmental Impact Assessment Report

Section 8

Climate

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8 CLIMATE

Climate is defined as an environmental factor under Directive 2011/92/EU, whilst Directive 2014/52/EU requires the vulnerability of a project to climate change to be addressed, particularly the risk of major accidents and/or disasters that are relevant to the project, including those caused by climate change.

The Intergovernmental Panel on Climate Change (IPCC 2013) defines "Climate, in a narrow sense, ….. is the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Classically the period for averaging these variables is 30 years, as defined by the World Meteorological Organization".

In the context of an EIAR, climate may refer to local climatological conditions (long-term weather patterns, e.g., local wind flow, temperature, rainfall, or solar radiation) and particular "microclimate" effects of the project location (e.g., due to localised heat island effects, the effects of buildings / shade or coastal effects). Climate may also refer to the impact of the project in the context of greenhouse gas (GHG) emissions and potential effects associated with climate change. Determining whether a project will have a significant impact on current and future climate requires an understanding of the vulnerability of the project to climate change, the likely magnitude of GHG emissions associated with the activity as well as an understanding of the likely local impacts of climate change throughout the timescale of the project.

8.1 INTRODUCTION

"Sustainable development is the kind of development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission 1987), and is the principle underpinning all current planning legislation. There is no greater challenge to meeting the latter obligation than the issue of human-induced global climate change. Developments can have implications on a national or global scale, where for example, it may represent a significant proportion of the national contribution of greenhouse gases. In the context of most Environmental Impact Assessment Reports (EIAR) however, climate is restricted in scope to the local climatological conditions or "microclimate" of an area, such as local wind flow, temperature, rainfall or solar radiation patterns.

For the purposes of Environmental Impact Assessment, a development may be seen to have potential climatic implications if its emissions are likely to alter meteorological conditions with possible weather effects.

This section of the EIAR addresses the issues related to climate for the proposed development at Spink Quarry, and its impact on the climate of the application site and its environs as a result of the activities being undertaken.

The prevailing weather systems are described with emphasis on the long-term patterns and trends. It involves an assessment of the prevailing climatic conditions and assesses the potential impact of the development on the latter.

8.2 REGULATORY BACKGROUND

8.2.1 CLIMATE CHANGE

8.2.1.1 Background

Climate change will continue to cause damage to the environment and compromise economic development. In this regard, it is appropriate to assess the impact of projects on climate (for example greenhouse gas emissions). The Directive also requires the vulnerability of a project to climate change to be addressed, particularly 'the risk of major accidents and/or disasters which are relevant to the project concerned, including those caused by climate change.

The EPA define climate change as a significant change in the measures of climate, such as temperature, rainfall, or wind, lasting for an extended period of decades or longer. The IPCC (2013) define climate change as "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer".

Natural factors that can give rise to climate change include: (a) changes in the sun's intensity, (b) volcanic eruptions; (c) slow changes in the Earth's orbit around the sun; and (d) variations within the climate system, such as changes in ocean current circulation. However, climate change has been attributed more recently to human activities through our emissions of greenhouse gases that are changing the composition of the earth's atmosphere. The main human activities that contribute to climate change include: (a) carbon dioxide emissions through burning fossil fuels, such as coal, oil and gas and peat; (b) methane and nitrous oxide emissions from agriculture; and (c) emissions through land use changes, such as deforestation, reforestation, urbanization, and desertification. Since the beginning of the industrial revolution, the increased burning of fossil fuels and deforestation have caused the concentrations of heat-trapping greenhouse gases to increase significantly in the atmosphere, which prevents heat from escaping to space.

The Fifth Assessment Report of the Inter-Governmental Panel on Climate Change (IPCC) published in 2013, states that "Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century. Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond. Most aspects of climate change will persist for many centuries even if emissions of CO_2 are stopped. This represents a substantial multi-century climate change commitment created by past, present and future emissions of CO_2".

The 2018 IPCC Special Report on Global Warming of 1.5°C states that the impacts of human-induced global warming of 1°C are already being felt in the intensity and frequency of some climate and weather extremes. Internationally, climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C, and will increase further if warming reaches 2°C. DoCCE (2021) state that observations show that Ireland's climate is changing, at a scale and rate consistent with regional and global trends.

8.2.1.2 Kyoto Protocol 1997

Member countries, including Ireland, ratified the United Nations Framework Convention on Climate Change (UNFCCC) in April 1994. It was soon augmented by an international agreement linked to the existing treaty, known as the Kyoto Protocol, with stricter demands for reducing greenhouse-gas emissions. The protocol was adopted in 1997 and entered into force on 16 February 2005. The Protocol's major feature is that it has mandatory targets on greenhouse-gas emissions for the world's leading economies. These targets range from - 8 per cent to + 10 per cent of the countries' individual 1990 emissions levels, with a view to reducing their overall emissions of such gases by at least 5 per cent below existing 1990 levels in the commitment period 2008 to 2012. In almost all cases, the limits call for significant reductions in currently projected emissions. A mechanism to set future more stringent mandatory targets for subsequent "commitment periods" after 2012 was established.

8.2.1.3 Paris Agreement 2015

The UNFCCC has continued on-going, detailed negotiations in relation to GHGs reductions and in relation to technical issues such as Emission Trading and burden sharing. The Conference of the Parties (COP21) was convened in Paris in 2015 and was an important milestone in terms of international climate change agreements. The so-called "Paris Agreement" builds upon the convention, and for the first time, brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The Paris Agreement was signed by over 200 nations (166 parties have ratified the agreement at the time of writing). The central aim of the agreement is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century below 2°C above pre-industrial levels, and to pursue efforts to limit the temperature increase even further to 1.5°C. The objective is to limit global GHG emissions to 40 giga tonnes as soon as possible, while acknowledging that peaking of GHG emissions will take longer for developing countries. Significant progress was also made on elevating adaption onto the same level as action to cut and curb emissions. The agreement requires all parties to put forward their best efforts through based on intended nationally determined contributions (INDCs), which will form the foundation for climate action post 2020.

The agreement also aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives.

The EU agreed the "2030 Climate and Energy Policy Framework" on the 23/24th of October 2014 (EU 2014). The European Council endorsed a binding EU target of at least a 40% domestic reduction in greenhouse gas emissions by 2030 compared to 1990. The target will be delivered collectively by the EU in the most cost-effective manner possible, with the reductions in the emissions trading system (ETS) and non-ETS sectors, amounting to 43% and 30% by 2030 compared to 2005, respectively. Secondly, it was agreed that all member states will participate in this effort, balancing considerations of fairness and solidarity. The policy also outlines, under “Renewables and Energy Efficiency”, an EU binding target of at least 27% for the share of renewable energy consumed in the EU in 2030.

8.2.1.4 National Policy, Plans & Legislation

The National Climate Policy Position established the national objective of achieving a competitive, low-carbon, climate-resilient and environmentally sustainable economy by 2050 (DoCCE 2021). It sets out the level of greenhouse gas mitigation ambition needed and establishes the process to achieve the overall objective. The National Policy Position envisages that policy development will be guided by a long-term vision based on:

- an aggregate reduction in carbon dioxide (CO_2) emissions of at least 80% (compared to 1990 levels) by 2050 across the electricity generation, built environment and transport sectors; and
- an approach to carbon neutrality in the agriculture and land-use sector, including forestry, which does not compromise capacity for sustainable food production.

The evolution of national climate policy will be based on the adoption by government of a series of national plans which will include early identification and ongoing updating of possible transition pathways to 2050 to inform sectoral strategic choices. National plans will be adopted and reviewed on a structural basis to ensure a coherent policy across all key sectors.

The enactment of the Climate Action and Low-Carbon Development Act 2015 was a landmark national milestone in the evolution of climate change policy in Ireland. The Act provides the statutory basis for the national transition objective laid out in the national policy position. As set out in the Act, the Minister for Communications, Climate and Environment must submit to government a series of successive plans and frameworks that will ensure the national transition objective is achieved by the implementation of cost-effective measures.

The National Adaptation Framework (NAF) was developed under the above Act and was published in January 2018 (DoCCE 2018). The NAF sets out the national strategy to reduce the vulnerability of the country to the negative effects of climate change and to avail of positive impacts. It provides a framework to ensure local authorities, regions, and key sectors can assess the key risks and vulnerabilities of climate change, implement actions to build resilience to climate change, and ensure climate adaptation considerations are mainstreamed into all local, regional, and national policy. Under NAF, seven government departments with responsibility for priority sectors were required to prepare sectoral adaptation plans. Each plan identifies the key risks faced across the sector and the approach being taken to address these risks and build climate resilience for the future. These plans are now in the implementation phase.

The production of aggregates was not explicitly identified to prepare a sectoral adaptation plan. Local authorities have essential local knowledge and have a critical role to play in managing climate risks and vulnerabilities and identifying adaptation actions that will build resilience locally. Consequently, local authorities are required to prepare local adaptation strategies. NAF also aims to improve the enabling environment for adaptation through ongoing engagement with civil society, the private sector, and the research community.

The Climate Action Plan 2019 sets out an ambitious course of action to adapt to climate disruption, which is already having diverse and wide-ranging impacts on Ireland's environment, society, economic and natural resources. The Climate Action Plan is Ireland's plan to tackle climate breakdown and achieve net zero greenhouse gas emissions by 2050. The plan clearly identifies the nature and scale of the challenge and outlines the current state of play across key sectors, including electricity, transport, built environment, industry, and agriculture, and charts a course towards ambitious decarbonisation targets.

8.2.1.5 Guidance

There is no guidance on the general climate other than, in respect of EIARs, the EPA's Draft Advice Notes for Preparing an Environmental Impact Statement (EPA 2015). Some of the guidance available specifically with respect to climate change is given below.

EU (2013). Guidance on Integrating climate change and Biodiversity into Environmental Impact Assessment. Available at https://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf

IEMA (2017). Assessing Greenhouse Gas Emissions and Evaluating their Significance. Available at https://www.iaia.org/pdf/wab/EIA%20Guide_GHG%20Assessment%20and%20Significance_IEMA_16May17.pdf

EU (2016). Climate Change and Major Projects. Available at https://ec.europa.eu/clima/sites/clima/files/docs/major_projects_en.pdf

DoCCE (2018). Sectoral Planning Guidelines for Climate Change Adaptation. Available at https://www.gov.ie/pdf/?file=https://assets.gov.ie/129614/9bcbb18e-7203-4079-9a59-833842e932f2.pdf#page=null

8.3 METHODOLOGY

The objective of this study was to:

- Assess the prevailing climatic conditions of the development area on a local and regional level;
- Determine the impact, if any, of the development on the local microclimate and regional macroclimate;
- Determine any interaction between other aspects of the development and the climate of the area;
- Estimate the developments GHG emissions; and
- Determine vulnerability of development to climate change.

8.3.1 STUDY

The study of climate in respect of the proposed development was entirely a desktop study, involving the compilation and analysis of data and information on weather, climate, climate change, and impact of, and vulnerability to, climate change.

8.3.2 SOURCES OF INFORMATION

The principal sources of information include:

- Met Eireann, Glasnevin, Dublin, Ireland;
- Environmental Protection Agency (EPA), Johnstown Castle, Wexford, Ireland;
- Sustainable Energy Authority of Ireland (SEAI), Dublin, Ireland;
- Intergovernmental Panel on Climate Change (IPCC), New York, USA; and
- European Union, Brussels, Belgium.

8.4 BASELINE DESCRIPTION OF RECEIVING ENVIRONMENT

8.4.1 CLIMATE

The application site is located within the Townland of Knockbaun, c. 4 km northwest of Swan, c. 7 km south of Timahoe, c. 9.5 km east of Abbeyleix, c. 10 km north of Castlecomer. The site is located in a rural setting. The site is situated in a wide bow in the R430 as it swings around the hill into which the quarry has been excavated from the northeast. The topography of the region is that of rolling hilly landscape with the site situated on the northwestern margin of the Castlecomer Plateau, where elevations typically vary from 180 m to 270 m Above Ordnance Datum (AOD). The site occurs at a maximum elevation of 261 m AOD along the southern boundary and a minimum elevation of 215 m AOD along the boundary with the R430 Regional Road. The general topographical trend of the landholding is the lower land to the southeast. Topographically, the lands are within the watershed of the Nore Liffey River Basin. Hydraulically, however, there is a divide through the centre of the site with the subcatchments of the River Clogh to the east and the River Owenbeg to the west.

As a small island downwind of an extensive ocean, the climate of Ireland is profoundly impacted by the Atlantic Ocean. The dominant influence on Ireland's climate is the Atlantic Ocean, such that Ireland does not suffer from the extremes of temperature experienced by many other countries at similar latitude. The warm North Atlantic Drift or Current has a marked influence on sea temperatures, the influence of which is strongest near the Atlantic coasts and decreases with distance inland.

The Atlantic circulation, which includes ocean currents such as the North Atlantic Current, moves heat northwards, which is then carried by the prevailing winds towards Ireland. The prevailing winds are westerly to southwesterly, and break on the hills and mountains of the west coast, which provide shelter from both the strong winds and from the direct oceanic influence. Rainfall is therefore a particularly prominent aspect of the climate in the west, with annual average precipitation highest on the west coast and in inland areas of high relief. Rainfall is much less prominent in the eastern half of the island.

The climate of Ireland is described as a typical "Temperate Maritime Climate", which is modified by the North Atlantic Current, and is overcast about half the time with consistently high average humidity. Winters tend to be cool, moist, and windy, while summers are mostly mild, cloudy, and less windy, when the depression track is further north and depressions less deep. For the greater part of the year, warm maritime air associated with the Gulf Stream helps to moderate the climate from the extremes of temperature experienced by many other countries at similar latitude.

A prominent feature of the atmospheric circulation in the North Atlantic, the polar front, plays an important role in the Irish climate (Met Eireann 2017). It's a zone of transition between warm, moist air (often of tropical origin) moving northwards and colder, denser, drier air (typically of polar origin) moving southwards. In winter, the polar front usually extends north eastwards from the east coast of the United States, whereas in summer it is less well-defined. Disturbances on the front sometimes amplify and deepen to form the large-scale depressions of the middle latitudes. These depressions often move north eastwards across the North Atlantic and pass to the northwest of Ireland. Ahead of the depression centres, warm moist air is swept northwards, while behind them colder, drier air is swept southwards. This gives the sequence of cloudy, humid weather with rain, followed by brighter, colder weather with showers so typical of the Irish climate.

Ireland experiences a range of air masses with different sources and tracks, giving us our variable weather. Air masses of polar origin are most common, but they usually have a long track over the Atlantic before reaching Ireland. Even southerly or southwesterly winds can bring us returning polar air, albeit highly modified by its excursion into the warm waters of the mid Atlantic. Air masses of direct tropical or polar origin are uncommon.

The World Meteorological Organization (WMO) recommends that climate averages are computed over a 30-year period of consecutive records. The period of 30 years is considered long enough to smooth out year to year variations. By collecting weather data from around the country every hour and by analysing these records over a long period of time, 30-year average values are calculated. Met Éireann now reference 1981 to 2010 as the baseline period for day-to-day weather and climate comparisons. The closest synoptic station to the Knockbaun site with 30-year averages for the 1981 to 2010 period is at Kilkenny, c. 27 km to the south. Notably, the Kilkenny station was replaced by the station at Oak Park, Carlow, in 2008, such that the 1978-2007 period is used for the 30-year averages.

Ireland has a typical temperate maritime climate, with relatively mild, moist winters and cool, cloudy summers. The prevailing winds are westerly to southwesterly. For the greater part of the year, warm maritime air associated with the Gulf Stream helps to moderate the climate from the extremes of temperature experienced by many other countries at similar latitude. The average humidity is high. Annual average precipitation is highest on the west coast and in inland areas of high relief.

8.4.1.1 Rainfall

Rainfall in Ireland normally arises from Atlantic frontal systems, which travel in a northeasterly direction delivering cloud and rain. Highest rainfall occurs in the Western half of the country and on high ground; rainfall generally decreases towards the northeast (See Figure 8.1). Averaged over all Ireland, the average annual rainfall is approximately 1,230 mm. The driest seasons are spring and summer, with an all-Ireland average of approximately 260 mm, autumn and winter have all Ireland averages of approximately 350 mm. The driest months are April, May, June, and July, with an all-Ireland average of approximately 80 mm each month. February, March, August, and September have average rainfall totals of approximately 100 mm, while October, November, December, and January have all Ireland averages of approximately 130 mm.

On an annual basis, averaged over the country, there has been an increase of approximately 5% in rainfall totals between the two normal periods (1961-1990 and 1981-2010), with the higher increases in the Western half of the country. All seasons show an overall increase in rainfall but there are regional differences. There are decreases of up to 10% in rainfall in the South and East in winter, with corresponding increases in the West and Northwest. Spring and summer show increases of 5-10%. While most months show an increase in rainfall of 5-10%, January and February had decreases of 5-10% in the South and East, while September had a general decrease of up to 10%. In July, the average increase in rainfall was in the order of 15%.

Long term rainfall and evaporation data was sourced from Met Éireann. The 30-year annual average rainfall (AAR) recorded at Kilkenny 27 km south of the site is given as 857.4 mm/yr.

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Kilkenny c. 27 km to the south of the site. Met Éireann's long-term average PE for this station is 533 mm/yr. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 506 mm/yr (which is 0.95 x PE). The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the site is calculated as the AAR – AE (i.e., 857.4 – 533), which gives a value of 324.4 mm/year.

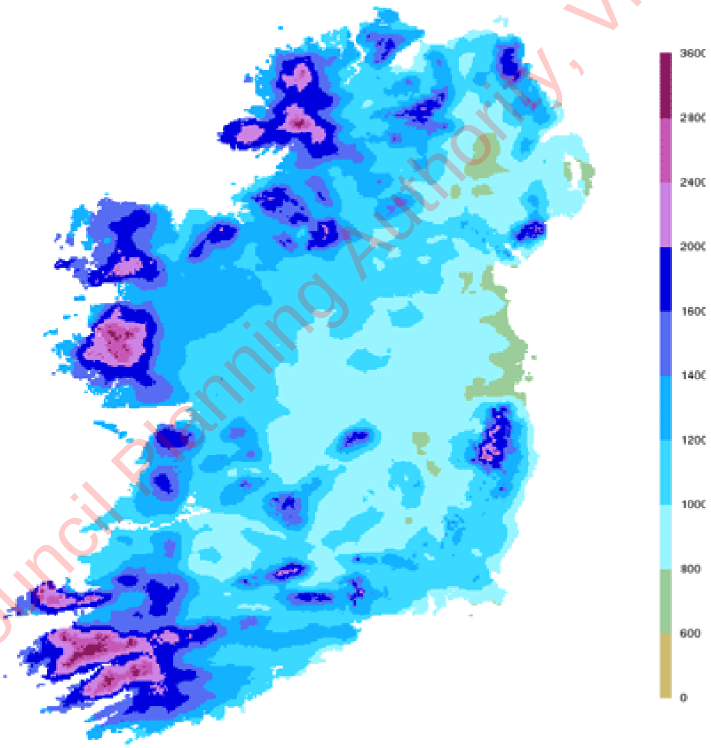

Figure 8.1 Mean Annual Rainfall (mm). Sourced from Met Eireann (2018)

8.4.1.2 Temperature

The temperature regime in Ireland is greatly affected by the moderating effect of the sea, and height above sea level. Mean annual temperatures generally range between 9°C and 10°C with the higher values in coastal regions. Summer is the warmest season, followed by autumn, spring and winter. Highest temperatures occur inland during the summer, with mean seasonal maxima between 18°C and 20°C, while highest values during the winter occur in coastal regions. July is the warmest month, followed by August and June; the coldest month is January followed closely by February and then December.

Generally, there has been an increase of approximately + 0.5°C in mean temperature between the 1961 - 1990 and the 1981 - 2010 periods, with the highest increases in the Southeast. Maximum and minimum temperatures have also increased by approximately + 0.5°C. All seasons show a rise in mean temperature with the spring and summer seasons displaying the largest differences between the two periods of approximately + 0.7°C. Almost all mean monthly temperatures show an increase, except October and December, which show small decreases of up to - 0.2°C in the West and Northwest.

The average daily air temperatures at Kilkenny (1978-2007) range from 5.9℃ to 13.8℃, with a mean 9.9℃. These values can be considered comparable to those expected at the application site.

8.4.1.3 Wind

The prevailing wind direction over Ireland is between south and west. Average annual wind speeds range from 3 m/s in parts of South Leinster to over 8 m/s in the extreme north. On average there are less than 2 days with gales each year at some inland places like Carlow, but more than 50 a year at northern coastal locations such as Malin Head.

During the course of a typical day, the range (difference between the highest and lowest) of mean hourly wind speed is considerable. At Belmullet, a western coastal station, the mean diurnal range is 11.5 m/s in January and is still as high as 8.4 m/s in July. At Clones, a typical inland station the mean diurnal range is 8.4 m/s in January and 6.2 m/s in July. The diurnal variation is much more pronounced in summer than in winter.

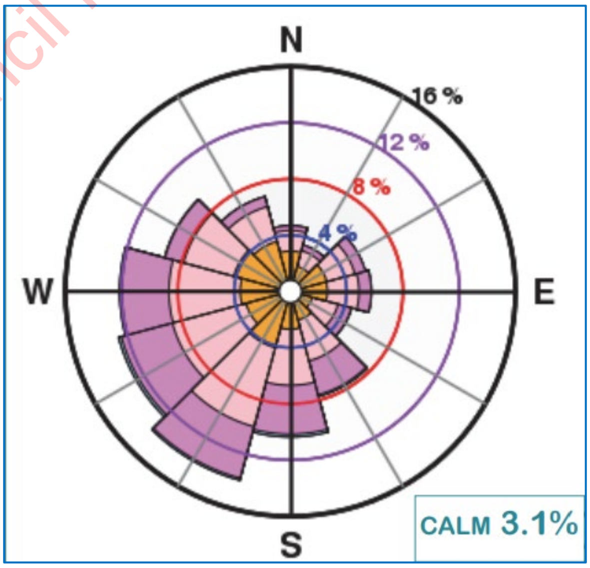

Figure 8.2 Mullingar Wind Rose based on 1981-2010 Averages. Sourced from Met Eireann (2021).

Wind blows most frequently from the south and west for open sites, while winds from the northeast or north occur least often. In January the southerly and southeasterly winds are more prominent than in July, which has a high frequency of westerly winds. Easterly winds occur most often between February and May and are commonly accompanied by dry weather.

The prevailing winds in this area are from the southwest and west as illustrated by the wind rose for the synoptic weather station at Mullingar (Kilkenny and Birr are unavailable) c. 70 km north of the site (Figure 8.2). Notable also is the low percent calm value of 3.1%.

8.4.2 CLIMATE CHANGE

8.4.2.1 Kyoto Protocol 1997

As a signatory nation to the Kyoto Protocol, and for the purposes of the EU burden sharing agreement under Article 4 of the protocol, Ireland agreed to limit the net anthropogenic growth of the six Greenhouse gases (GHGs; principally CO_2 emissions) under the protocol to 13% above the 1990 level (i.e., 55.5 Mt Co_{2eq}) over the period 2008 to 2012 (ERM, 1998). There have been substantial reductions in Ireland's GHG emissions in recent years, due in significant part to the impact of the economic downturn. Under the Kyoto Protocol, Ireland's total emissions are limited to an average of 62.8 Mt CO_{2eq} per annum for the first commitment period 2008 - 2012. By 2012, Ireland was 5.68 Mt CO_{2eq} below the Kyoto commitment for the period, and thus broadly on track to meet its commitment under the Kyoto Protocol first commitment period. However, when the impact of the EU Emissions Trading Scheme and forest sinks are taken into account, Ireland exceeded the Kyoto limit by 2.1 Mt CO_{2eq} (EPA 2014a).

Although Ireland is currently on track to meet its Kyoto second commitment period 2013-2030 targets, there remains significant risk that these will not be met, even under the most ambitious emission reduction scenario. Ireland's GHG emissions increased from 1990 to 2001, where it peaked at 70.46 Mt CO_{2eq}, before displaying a downward trend to 2014. In 2019, provisional estimates of total national GHG emissions amounted to 59.78 Mt CO_{2eq}, indicating that Ireland's GHG emissions have increased by 7.93% during 1990-2019.

In 2019, the energy industries, transport and agriculture sectors accounted for 71.4% of total GHG emissions. Agriculture is the single largest producer of GHG emissions with 35.3%, whilst transport, energy industries and the residential sector are the next largest producers with 20.3%, 15.8% and 10.9%, respectively.

Emissions are projected to increase in 2020-2030 (12% in total), with strong growth in emissions from transport and agriculture, indicating that Ireland is not on a pathway to a low-carbon economy (EPA 2014b). Thus, rather than rely on economic recession, Ireland needs to develop as a low carbon economy in order to meet future targets.

8.4.2.2 Paris Agreement 2015

In terms of 2030 reduction targets, the EU Effort Sharing Regulation (ESR) requires that Ireland reduce its non-Emissions Trading Scheme (non-ETS) emissions by 30%

on 2005 levels by 2030. However, projections indicate that Ireland will exceed the carbon budget of 378.3 Mt CO_{2eq} by 50.8 Mt CO_{2eq} over the 2021–2030 period.

Ireland's National Policy position is to reduce CO_2 emissions in 2050 by 80% on 1990 levels across the energy generation, built environment and transport sectors, with a view to Climate neutrality in the agriculture and land-use sector. The extent of the challenge to meet the national 2050 targets is clear and will require robust measures at the national policy and regulatory level.

8.4.2.3 Impact of Climate Change on Ireland

Much of the discussion on climate change revolves around the issue of rising global temperatures. The EPA notes that the temperature records show a mean temperature increase of 0.7℃ between 1890 and 2008, which corresponds to an increase of 0.06℃ per decade. However, the increase during the period 1980–2008 corresponds to 0.14℃ per decade and suggests an accelerating trend in global warming. Other indicators include: (a) six of the ten warmest years in Ireland have occurred since 1990; (b) a reduction in the number of frost days and shortening of frost season length; and (3) an increase in annual rainfall in northern and western areas with a decrease or small increase in the south and east. Further, ocean acidification has emerged as another significant issue, which will have harmful effects on marine organisms and has the potential to disrupt global marine ecosystems.

Climate change impacts are projected to increase during the rest of this century, with significant uncertainties remaining in relation to the scale and extent of these impacts. Projections of global temperatures to 2030, and beyond, based on multiple climate models, indicate widening band of potential trajectories, with predicted temperatures of 0.5℃ – 2℃ above 1960–1990 temperatures. The greatest uncertainly lies in how effective global actions will be in reducing greenhouse gas emissions. Predicted adverse impacts include:

- Sea level rise, with minor inundation of low lying coastal areas;
- More intense or extreme storms (incl. storm surges) and rainfall events;
- Increased likelihood and magnitude of river and coastal flooding;
- Water shortages in summer in the east;
- Adverse impacts on water quality;
- Changes in distribution of plant and animal species; and
- Effects on fisheries sensitive to changes in temperature.

Paradoxically, some studies have reported that global warming due to climate change could shut-down or retard the North Atlantic Current and result in colder average temperatures in Ireland. A huge amount of heat is circulated by a single ocean current system - the Atlantic Meridional Overturning Circulation (AMOC), also known as the Atlantic Conveyor Belt. The system is driven by density, with denser waters that are cold or salty sinking to the ocean floor in the North Atlantic and flowing southwards, while warm tropical waters at the surface flow northwards in the North Atlantic Current or Gulf Stream, rendering northern Europe unusually mild for its latitude. This density-driven mechanism could become weakened if the northern waters get too warm or too fresh from melting ice. IPCC (2013) report that the AMOC will most likely weaken over the 21st century, with a best estimate of 34% loss.

8.4.2.4 Vulnerability to Climate Change

Vulnerability to climate change has been defined as "the degree to which a system [natural or human] is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC 2013). Thus, exposure is viewed as an external dimension, while sensitivity and adaptive capacity are viewed as internal dimensions of vulnerability.

Exposure to climate variation is primarily a function of geography, in that coastal communities will have higher exposure to sea level rise and cyclones, while communities in semi-arid areas may be most exposed to drought. IPCC (2013) state that "Sensitivity is the degree to which a given community or ecosystem is affected by climatic stresses", while "Adaptive Capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences". Access to and control over natural, human, social, physical, and financial resources is one of the most important factors shaping the adaptive capacity of individuals and communities. Whereas climate impacts can generally be described quantitatively by changes in biophysical indicators or in socio-economic indicators, there is no agreed metric to quantitatively describe the vulnerability of a natural system or sector. Consequently, vulnerability seems to be a relative measure rather than a quantity that can be expressed in absolute terms. Therefore, a vulnerability assessment might consider climate change projections, the socio-economic setting, and estimates of the adaptive capacity of the project.

Resilience is the ability of a system to resist, absorb, and recover from the effects of hazards in a timely and efficient manner, preserving or restoring its essential basic structures, functions, and identity. Resilience is a familiar concept in the context of disaster risk reduction (DRR) and is increasingly being discussed in terms of adaptation to climate change. Resilience enables management of hazards to minimize their effects and/or to recover quickly from any negative impacts and needs to be incorporated into the fabric of projects to future-proof them against increasingly extreme weather.

It is expected that climate change will increasingly impact on Ireland over the coming decades. The most immediate risks to Ireland are mainly those associated with changes in extremes such as floods, precipitation, and storms. The impact of climate change at Knockbaun is likely to manifest as more intense storms and rainfall events, as well as increased likelihood and magnitude of flooding.

Ireland's Catchment Flood Risk Assessment and Management (CFRAM) Programme is central to the medium and long-term strategy for the reduction and management of flood risk throughout Ireland. The CFRAM flood maps are now the primary reference for flood risk planning in Ireland. These flood maps are 'predictive' maps showing areas predicted to be inundated during a theoretical or 'design' flood event with an estimated probability of occurrence. The maps give the probability of a flood event of a given severity occurring in any given year, and can be expressed as odds (e.g., 100 to 1) of the event occurring in any given year or in terms of a return period (e.g., the 100-year flood). The low annual exceedance probability corresponds to odds of flooding of 1,000:1 or a 1,000 year flood.

To identify those areas as being at risk of flooding, we consulted the OPW's indicative river and coastal flood map (https://www.floodinfo.ie/map/floodmaps/). No recurring flood events in the area of the proposed site were identified from OPW's indicative river and coastal flood map, the nearest being c. 8 km to the northwest at Ballyroan and Abbeyleix. There are no flood events identified as having occurred, nor areas with low, medium, or high probability of flooding, along the tributaries and mainstreams of the River Owenbeg or River Clogh within c. 10 km of the site (i.e., at Ballyragget and Castlecomer). Thus, the flood risk posed to the proposed development site in respect of fluvial flooding is currently insignificant.

Given that urban planning and engineering design safety factors are normally based on a 100 year event, the low probability map, representing a 1,000 year event, should provide a proxy of the flooding expected during at least the early years of climate change. This assessment is expected to change over time as future iterations of the flood maps incorporate new rainfall and flood data that reflect the ongoing progression of climate change.

There is a low risk of pluvial flooding (i.e. rainfall ponding) at the site as rainfall landing in the quarry that is collected as surface water run-off will be managed through the settlement pond system prior to discharge to an external watercourse.

Climate change adaptation will be integrated into the proposed development based on its vulnerability and should ensure adequate resilience to the adverse impacts of climate change. It has been calculated that the stormwater generated during a 1 in 100 year event of 18 hours duration is 16,752 m^3 (Refer Section 7). As the applicant intends to limit the discharge rate from the sump to the ponds to a maximum of 1,453 m^3/d, this gives an extreme rainfall event storage requirement of 15,650 m^3 over the same 18 hour duration. The quarry will be capable of withholding any stormwater generated during extreme rainfall events and runoff in excess of 1,453 m^3/d (Refer Section 7). Sustainable quarry dewatering requires that the local natural surface water drainage network has adequate capacity to receive and safely transmit the potential discharge rates outlined above. The hydrological evaluations included an assessment as to whether quarry discharge could increase the risk of flooding in downstream receptors and adjoining land (Refer to EIAR Section 7.5.9).

The results show that the discharge can be adequately accommodated by the receiving water and will cause only a negligible increase in stream water levels during an extreme storm event, including allowance for climate change. Hydraulic modelling based on cross sections and surveying was applied to demonstrate that the surface water system could accommodate the envisaged dewatering amounts, in combination with flood flows and allowances for climate change.

8.4.2.5 Greenhouse Gas Emissions

Mineral extraction by quarrying is defined as a heavy industry and requires the use of heavy plant and machinery, each of which are energy intensive. The crushing, screening and transport of rock and aggregates are typical examples of the use of machinery in quarry operations. Most plant used in the quarry is likely to run on diesel. Unless powered by green electricity, the plant and machinery will result in the direct generation of GHG emissions.

The scale of the operation at Knockbaun under planning permission P.A. Ref. 10/383 was up to a maximum output of 350,000 tonnes per annum, although it is proposed that the average output will be closer to c. 200,000 tonnes per annum, giving an anticipated duration for the extraction of c. 29 years. A quarry of this magnitude would be considered to be a small to mid-size scale of operation.

Quarries in Ireland produced c. 0.18 million tonnes of CO_{2eq} emissions in 2019, accounting for 0.3% of the national CO_{2eq} emissions budget. If we assume 500 active quarries (estimate by the GSI 2021), then the average quarry produces c. 360 tonnes CO_{2eq} emissions per annum.

8.4.3 AIR QUALITY

Air quality in Ireland is of a high standard across the country and is among the best in Europe, meeting all EU air quality standards in 2010. This is due largely to prevailing clean Atlantic air and a lack of large cities and heavy industry. Over the past decade, levels of particulate matter have decreased in cities and large urban areas, arising principally from improvements in vehicle engine technology.

For Ireland to comply with its international commitments on air quality and air emissions, industrial emissions of pollutants to air must continue to be rigorously controlled; policies must be implemented to increase the use of alternatives to the private car and improve efficiencies of motorised transport. Government departments, national agencies and local authorities must make air quality an integral part of their traffic management and planning processes. Households and businesses must shift from solid fuel to cleaner and more efficient alternatives including gas.

Refer to EIAR Section 9.2.1.3 for a full discussion of the national and European policy and legislative background to air quality.

8.5 ASSESSMENT OF IMPACTS

The following Impact Assessment matrix provides an indication of the significance of potential effects arising during the life cycle of the development not accounting for any mitigation measures.

Table 8.1 Climate - Impact Matrix

'Do Nothing' Impacts	X		
Factors	**Construction**	**Operation**	**Decommissioning**
Direct Impacts	X	X	X
Indirect Impacts	X	X	X
Cumulative Impacts	X	X	X
Residual Impacts	X	X	X
`Worst Case' Impacts	X	X	X

None/imperceptible: X; Slight: ●; Moderate: ●; Significant/Very significant: ●.

Refer to Appendix 3 for definition of Significance

8.5.1 'DO NOTHING' IMPACTS

If the proposed development is not granted planning permission, local demand for road aggregate may require materials to be transported from further afield, with a consequential impact in terms of increased vehicular exhaust emissions. It is considered that failure to continue the quarry will nonetheless have an imperceptible negative impact with respect to climate.

8.5.2 DIRECT IMPACTS

The scale of the operation under planning permission P.A. Ref. 10/383 was up to a maximum output of 350,000 tonnes per annum. The proposed development will not exceed this level and the average output will be closer to c. 200,000 tonnes per annum. This is not of a sufficient scale to have any significant direct impacts on the regional or local climatic conditions.

8.5.3 INDIRECT IMPACTS

GHG emissions from plant and machinery at the Spink Quarry will represent of the order of 0.001 % of Ireland's national carbon budget, which is a medium- to long-term, imperceptible impact in terms of Ireland's contribution to climate change.

8.5.4 CUMULATIVE IMPACTS

The effect of climatic conditions (e.g., rainfall, wind, etc.) on other potential impacts of the development (e.g., dust deposition, drainage, etc.), are dealt with in the relevant sections of this EIAR. The cumulative impact of the quarry with respect to other developments has also been taken into consideration elsewhere in the preparation of the EIAR. The absence of large scale commercial and industrial developments within 3 km of the quarry negates any significant cumulative impact on the climate or climate change.

8.5.5 RESIDUAL IMPACTS

As a result of the proposed mitigation and enhancement measures incorporated in the design, no significant, long-term, adverse residual impacts are predicted in terms of Climate during the operational phase.

It is considered that following full restoration and closure of the site that there will be a slight to imperceptible positive impact with respect to Climate due to restoration of the lands to a wildlife amenity. The land-use change from a quarry to a wildlife amenity will result in a net increase in carbon sequestration, and thus a long-term, imperceptible, positive impact in terms of climate change.

8.5.6 'WORST CASE' IMPACT

There is no worst case impact on the regional or local climatic conditions with respect to the proposed development. In terms of climate change, the use of poorly maintained, inefficient, diesel-powered plant and machinery would generate GHG emissions in excess of that expected from a quarry operated under normal conditions.

8.6 MITIGATION & MONITORING

As the development is not expected to affect the local climate or microclimate of the area, there is no requirement for mitigation or monitoring within this development proposal in respect of climatic issues. Therefore, there are no mitigations proposed specifically with regard to the climate. Any impact on the natural environment will be mitigated against to the greatest degree practical, thereby minimising any associated impact on the climate.

Nonetheless, the proposed development will ultimately lead to the restoration of the quarry lands to a wildlife amenity, which will generate no further emissions from fossil fuels or dust, further lessening any impact on the climate.

The impact of climate change at Knockbaun is likely to manifest as more intense storms and rainfall events, with the increased likelihood and magnitude of fluvial flooding. Given that the proposed development is for an increase in depth of the existing quarry and continuing of extraction below the water table, the capacity of the sump, settlement pond system and external watercourse, to which it will discharge, to handle excess surface water run-off from heavy rainfall events probably represents the greatest vulnerability of the development to climate change.

The resilience of infrastructure to withstand storms, heavy rainfall events and high winds associated with extreme weather events triggered by climate change needs to be integrated into the design of the on-site infrastructure. In the event of a storm or heavy rainfall, the sump and/or quarry void, whether partly restored or not, would act as a water retention measure and retain substantial volumes of water and thus lower the risk of flooding.

Climate change mitigation can also be integrated into the proposed development, in order to reduce the emissions of GHGs. For example, significant avoidance of GHG emissions can be achieved by the use of concrete batching plant powered by mains electricity as compared to diesel generators. Where GHG emissions cannot be avoided, the significance of a project's emissions can be reduced by mitigation, such as use of energy efficient plant, appropriately sized plant, and maintaining equipment to optimise process efficiency.

The applicant, Lagan Materials Ltd. (Lagan), implement an Energy and Carbon Policy (Refer to Appendix 5) which has been developed by Breedon Group plc, Lagan's parent company. This policy commits to operating in a manner that ultimately eliminates its contribution to global warming by mitigation of climate change impacts through industrial innovation and the application of industry best practice (Breedon 2021). Some of the more relevant commitments are given below and indicate different measures that can be taken to lower the carbon footprint of the development:

- create and maintain a robust energy and carbon data collection and reporting system, that provides the data required to assess performance, identify opportunities for progress and to deliver improvements in performance;
- set targets for the short and medium-term with a goal of achieving carbon neutrality by 2050;

- monitor and measure performance regularly to ensure continual improvement and sharing of best practice;
- report annual climate-related emissions data and ensure that the reported data is externally verified by a recognised, accredited body;
- seek to reduce carbon emissions through optimizing energy efficiency and, where practicable, the use of alternative and renewable energy sources;
- regularly audit operations for energy efficiency opportunities and implement cost-effective solutions; and
- endeavour to transition our operational fleets from traditional combustion engines to alternative forms of energy and, through collaboration with suppliers, make our fleets more efficient through new technology.

8.7 REFERENCES

Breedon (2021). *Energy and Carbon Policy Statement*. Breedon Group, Dublin, Ireland.

DoCCE (2018). *Sectoral Planning Guidelines for Climate Change Adaptation*. Department of Communications, Climate and Environment (DoCCE), Dublin, Ireland. Available at https://www.gov.ie/pdf/?file=https://assets.gov.ie/129614/9bcbb18e-7203-4079-9a59-833842e932f2.pdf#page=null

DoCCE (2018). *National Adaptation Framework* (NAF). Department of Communications, Climate and Environment (DoCCE), Dublin, Ireland. Available at https://www.gov.ie/en/publication/fbe331-national-adaptation-framework/

DoCCE (2019). *Climate Action Plan 2019*. Department of Communications, Climate and Environment (DoCCE), Dublin, Ireland. Available at https://www.gov.ie/en/publication/ccb2e0-the-climate-action-plan-2019/

DoCCE (2021). *National Climate Policy*. Department of Communications, Climate and Environment (DoCCE), Dublin, Ireland. Available at https://www.gov.ie/en/policy-information/56654e-national-climate-policy/

EPA (2014a). *Ireland's Greenhouse Gas Emissions in 2012*. Environmental Protection Agency (EPA), Johnstown Castle, Wexford, Ireland, 8 p.

EPA (2014b). *Ireland's Greenhouse Gas Emission Projections 2013-2030*. Environmental Protection Agency (EPA), Johnstown Castle, Wexford, Ireland, 16 p.

EPA (2021). *Greenhouse Gas Emissions*. Online website. Environmental Protection Agency (EPA), Johnstown Castle, Wexford, Ireland. Available at https://www.epa.ie/ghg/

EU (2013). *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment*. Available at https://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf

EU (2016). *Climate Change and Major Projects*. Available at https://ec.europa.eu/clima/sites/clima/files/docs/major_projects_en.pdf

IPCC (2013). *Climate Change 2013: The Physical Science Basis*. Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press. Available at www.cambrdige.org

Met Éireann (2012). *A summary of Climate Averages for Ireland 1981-2010*. Climatological Note No.14. Met Éireann, Glasnevin Hill, Dublin, Ireland, 16 p.

Met Éireann (2014). *Online website*. Met Éireann, Glasnevin Hill, Dublin 9, Ireland. Available at http://www.met.ie

SEI (2009). *Energy in Ireland: Key Statistics 2009*. Sustainable Energy Ireland (SEI), Dublin, Ireland, 31 p.

UN (1987). *Our Common Future*. World Commission on Environment and Development (Bruntland Commission), United Nations (UN), New York, US. Available at www.un-documents.net/our-common-future.pdf

IEMA (2017). *Assessing Greenhouse Gas Emissions and Evaluating their Significance*. Available at https://www.iaia.org/pdf/wab/EIA%20Guide_GHG%20Assessment%20and%20Significance_IEMA_16May17.pdf

Internet Sources

DoCCE (2021). https://www.gov.ie/en/policy-information/37d691-adapting-to-climate-breakdown/

Floodmaps (2021). https://www.floodinfo.ie/map/floodmaps/

ICF (2021). https://www.irishconcrete.ie/backbone-sustainable-construction/quarries-and-aggregates/