11 AIR QUALITY

11.1 INTRODUCTION

AWN Consulting Ltd. has been commissioned to carry out an air quality impact assessment including an air dispersion modelling study of air and odour emissions from the existing facility and the licensed waste management activities at Drehid Waste Management Facility (WMF) at the townlands of Timahoe West, Coolcarrigan, Killinagh Upper, Killinagh Lower, Drummond, Kilkeaskin, Loughnacush, and Parsonstown, Carbury, County Kildare based on the design details.

This chapter was completed Dr. Avril Challoner. She is a Senior Consultant in the Air Quality section of AWN Consulting. She holds a BEng (Hons) in Environmental Engineering from the National University of Ireland Galway, HDip in Statistics from Trinity College Dublin and has completed a PhD in Environmental Engineering (Air Quality) in Trinity College Dublin. She is a Member of the Institute of Air Quality Management and specialises in the fields of air quality, EIA and air dispersion modelling.

Drehid WMF comprises an engineered landfill and a Composting Facility and is licensed by the EPA (IED Licence number W0201-03). The engineered landfill is currently permitted to accept a maximum of 120,000 TPA. The Composting Facility is permitted to accept 25,000 TPA.

The existing Drehid WMF includes;

- Landfill facility;
- Gas Utilisation Plant;
- Flares; and
- Composting Facility;

The purpose of this assessment is to determine whether the air and odour emissions from the facility will lead to ambient concentrations which are in compliance with the relevant ambient air quality standards and guidelines for odour, NO_2 & PM_{10}/$PM_{2.5}$. The assessment was conducted using the methodology outlined in *"Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)*" (EPA, 2010). This assessment describes the outcome of this study. The study of the current and ongoing emission scenarios consists of the following components;

- Review of emission data and other relevant information needed for the modelling study;
- Summary of background pollutant levels;
- Dispersion modelling of released substances (including odour, NOx and Particulates) under current and ongoing emission scenario;
- Presentation of predicted ground level concentrations of released substances;
- Evaluation of the significance of these predicted concentrations, including consideration of whether these ground level concentrations are likely to exceed the relevant ambient air quality and odour limit values and guideline values; and

- Impact of traffic related to ongoing activities for five pollutants of concern in the vicinity of the facility.

Information supporting the conclusions has been detailed in the following sections. The assessment methodology and study inputs are presented below. The dispersion modelling results and assessment summaries are presented in Section 11.4. The model formulation is detailed in Appendix 11.1. Figure 11.1 shows the location of the existing facility.

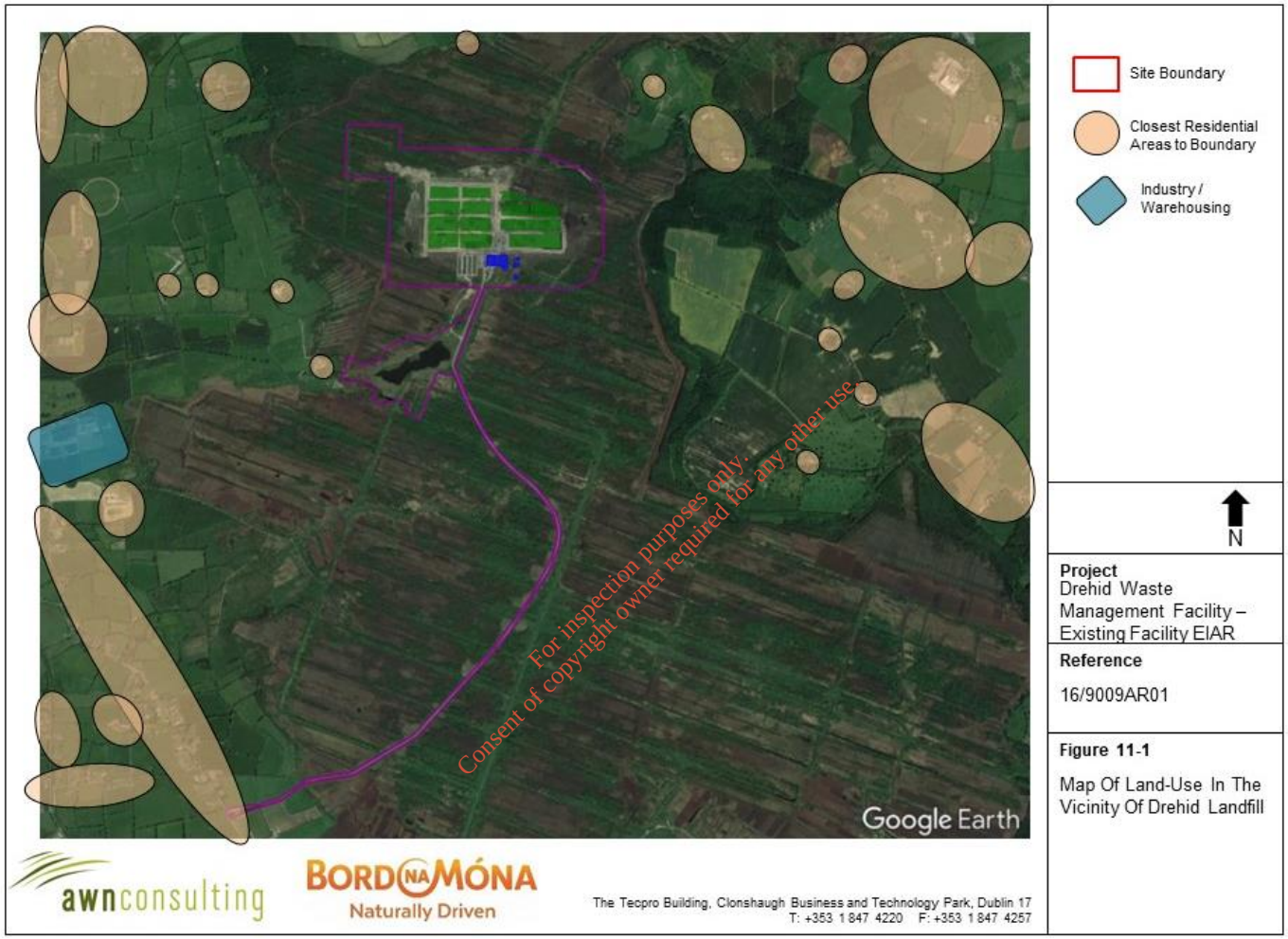


Figure 11.1: Map of Land-Use in The Vicinity Of Drehid Landfill

11.2 ASSESSMENT METHODOLOGY

Emissions from the existing facility have been modelled using the AERMOD dispersion model (Version 18081) which has been developed by the U.S. Environmental Protection Agency (USEPA) (USEPA 2004a) and following guidance issued by the EPA (EPA 2010). The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources and has replaced ISCST3 (USEPA 1995) as the regulatory model by the USEPA for modelling emissions from industrial sources in both flat and rolling terrain (USEPA 1998, 2000, 2005). The model has more advanced algorithms and gives better agreement with monitoring data in extensive validation studies (USEPA 1999, Schulman, L.L et al 2000, Paine, R & Lew F 1997a, 1997b, USEPA 2000). An overview of the AERMOD dispersion model is outlined in Appendix 11.1.

The air quality and odour dispersion modelling input data consisted of information on the physical environment (including building dimensions and terrain features), design details from all emission points on-site and five years of appropriate hourly meteorological data. Using this input data, the model predicted ambient ground level concentrations beyond the site boundary for each hour of the modelled meteorological years. The model post-processed the data to identify the location and maximum of the worst-case ground level concentration. This was then compared with the relevant ambient air quality and odour standards to assess the significance of the releases from the site.

The air quality impact associated with increased traffic was carried out following procedures described in the publications by the EPA (EPA 2002, 2003, 2015, 2017) and using the methodology outlined in the policy and technical guidance notes, LAQM.PG(16) and LAQM.TG(16), issued by UK Department for Environment, Food and Rural Affairs. Modelling was carried out for the current and ongoing activities at the Drehid WMF. The derived concentrations are then compared to EU ambient air quality standards.

11.2.1 Odour Assessment

11.2.1.1 Characteristics of Odour

Odours are sensations resulting from the reception of a stimulus by the olfactory sensory system, which consists of two separate subsystems: the olfactory epithelium and the trigeminal nerve. The olfactory epithelium, located in the nose, is capable of detecting and discriminating between many thousands of different odours and can detect some of them in concentrations lower than those detectable by currently available analytical instruments (Water Environment Federation, 1995). The function of the trigeminal nerve is to trigger a reflex action that produces a painful sensation. It can initiate protective reflexes such as sneezing to interrupt inhalation. The olfactory system is extremely complex and peoples' responses to odours can be variable. This variability is the result of the following; differences in the ability to detect odour, subjective acceptance or rejection of an odour due to past experience, circumstances under which the odour is detected, and the age, health and attitudes of the human receptor.

11.1.1.1.1 Odour Intensity and Threshold

Odour intensity is a measure of the strength of the odour sensation and is related to the odour concentration. The odour threshold refers to the minimum concentration of an odorant that produces an olfactory response or sensation. This threshold is normally determined by an odour panel consisting of a specified number of people, and the numerical result is typically expressed as occurring when 50% of the panel correctly detect the odour. This odour threshold is given a value of one odour unit and is expressed as 1 OU_E/m^3. The odour threshold is not a precisely determined value but depends on the sensitivity of the odour panellists and the method of presenting the odour stimulus to the panellists. An odour detection threshold relates to the minimum odorant concentration required to perceive the existence of the stimulus, whereas an odour recognition threshold relates to the minimum odorant concentration required to recognise the character of the stimulus. Typically, the recognition threshold exceeds the detection threshold by a factor of 2 to 10 (Water Environment Federation, 1995).

11.1.1.1.2 Odour Character

The character of an odour distinguishes it from another odour of equal intensity. Odours are characterised on the basis of odour descriptor terms (e.g. putrid, fishy, fruity etc.). Odour character is evaluated by comparison with other odours, either directly or through the use of descriptor words.

11.1.1.1.3 Hedonic Tone

The hedonic tone of an odour relates to its pleasantness or unpleasantness. When an odour is evaluated in the laboratory for its hedonic tone in the neutral context of an olfactometric presentation, the panellist is exposed to a stimulus of controlled intensity and duration. The degree of pleasantness or unpleasantness is determined by each panellist's experience and emotional associations. The responses among panellists may vary depending on odour character; an odour pleasant to many may be declared highly unpleasant by some.

11.1.1.1.4 Adaptation

Adaptation, or Olfactory Fatigue, is a phenomenon that occurs when people with a normal sense of smell experience a decrease in perceived intensity of an odour if the stimulus is received continually. Adaptation to a specific odorant typically does not interfere with the ability of a person to detect other odours. Another phenomenon known as habituation or occupational anosmia occurs when a worker in an industrial situation experiences a long-term exposure and develops a higher threshold tolerance to the odour.

11.2.1.2 Odour Guidelines

The exposure of the population to a particular odour consists of two factors; the concentration and the length of time that the population may perceive the odour. By definition, 1 OU_E/m^3 is the detection threshold of 50% of a qualified panel of observers working in an odour-free laboratory using odour-free air as the zero reference (the selection criteria result in the qualified panel being more sensitive to a

particular odorant than the general population). The recognition threshold is generally about five times this concentration (5 OU_E/m^3) and the concentration at which the odour may be considered a nuisance is between 5 and 10 OU_E/m^3 based on hydrogen sulphide (H_2S) (Warren Spring Laboratory, 1980). Clarkson and Misslebrook (C.R. Clarkson and T.H. Misselbrook, 1991) proposed that a "faint odour" was an acceptable threshold criterion for the assessment of odour as a nuisance. Historically, it has been generally accepted that odour concentrations of between 5 and 10 OU_E/m^3 would give rise to a faint odour only, and that only a distinct odour (concentration of >10 OU_E/m^3) could give rise to a nuisance (J.E. McGovern & C.R. Clarkson 1994). However, this criterion has generally been based on waste water treatment facilities where the source of the odour is generally hydrogen sulphide. In 1990, a survey of the populations surrounding 200 industrial odour sources in the Netherlands showed that there were no justifiable complaints when 98%ile compliance with an odour exposure standard of a "faint odour" (5-10 OU_E/m^3) was achieved (CH2M Beca Ltd, 2000).

The odour which is generated within the Facility consists of the current municipal solid waste landfill and composting. As detailed further in the discussion on Odour in this Chapter, odour will continue to be generated from the capped phases of the MSW landfill, although at a lower emission rate than when the MSW landfill is being actively landfilled.

The composting facility is ducted with air directed to biofilters; untreated odours are unlikely to be significant. Biofilter media are solid porous material which react with the odorous material through biological oxidation leading to usually much less odorous compounds. In general, biofilters typically have a distinct residual odour which will not be far below 100-300 OU_E/m^3 (CH2M Beca Ltd 2000, EPA & OdourNet UK 2000). However, this residual odour will in most cases resemble the odour of the soil, which is an earthy odour generally not recognised as annoying, as its character resembles that of odours naturally emitted from soil (CH2M Beca Ltd, 2000).

DEFRA (Environment Agency 2002, 2003) in the UK has published detailed guidance on appropriate odour threshold levels based in part on the offensiveness of the odour. As shown in Table 11.1, a landfill facility is included in the list with a UK ranking of 20. Green waste composting is also included and is similarly ranked with moderately odorous industries such as fish smoking and sugar production. Composting of MSW is not included in the list although the untreated odour generated could be considered similar, at various stages of the process, to other waste treatment facilities such as landfills or wastewater treatment facilities.

DEFRA has also detailed installation-specific exposure criteria based on the "annoyance potential" (Environmental Agency, 2002) which is defined as "the likelihood that a specific odorous mixture will give reasonable cause for annoyance in an exposed population". Industrial sources have been ranked into three categories based on their relative offensiveness which are "low", "medium" and "high" and exposure criteria assigned to each category, as shown in Table 11.2. The relevant exposure criteria vary from 1.5 OU_E/m^3 for highly odorous sources to 6.0 OU_E/m^3 for the least offensive odours. The relevant

exposure criteria for green waste composting is 3.0 OU_E/m^3 which should be expressed as a 98th%ile and based on one hour means over a one-year period in the absence of any local factors.

Table 11.1: Ranking Table For Various Industrial Sources (Environment Agency, 2002)

Environmental Odour	Ranking	Ranking	Ranking
Industrial Source	UK Median	UK Mean	Dutch Mean
Bread Factory	1	2.5	1.7
Coffee Roaster	2	3.9	4.6
Chocolate Factory	3	4.6	5.1
Beer Brewery	6	7.7	8.1
Fragrance & Flavour Factory	8	8.5	9.8
Charcoal Production	8	9.2	9.4
Green Fraction composting	**9**	**10.3**	**14**
Fish smoking	9	10.5	9.8
Frozen Chips production	10	11	9.6
Sugar Factory	11	11.3	9.8
Car Paint Shop	12	11.7	9.8
Livestock odours	12	12.6	12.8
Asphalt	13	12.7	11.2
Livestock Feed Factory	15	14.2	13.2
Oil Refinery	14	14.3	13.2
Car Park Bldg	15	14.4	8.3
Wastewater Treatment	17	16.1	12.9
Fat & Grease Processing	18	17.3	15.7
Creamery/milk products	10	17.7	-
Pet Food Manufacture	19	17.7	-
Brickworks (burning rubber)	18	17.8	-
Slaughter House	19	18.3	17.0
Landfill	20	18.5	14.1

Table 11.2: Indicative Odour Standards Based On Offensiveness Of Odour (Environment Agency, 2002)

Industrial Sectors	Relative Offensiveness of Odour	Indicative Criterion
Rendering Fish Processing Oil Refining Creamery WWTP Fat & Grease Processing	High	1.5 OU_E/m^3 as a 98th%ile of hourly averages at the worst-case sensitive receptor
Intensive Livestock Rearing Food Processing (Fat Frying) Paint-spraying Operations Asphalt Manufacture	Medium	3.0 OU_E/m^3 as a 98th%ile of hourly averages at the worst-case sensitive receptor
Brewery Coffee Roasting Bakery Chocolate Manufacturing Fragrance & Flavouring	Low	6.0 OU_E/m^3 as a 98th%ile of hourly averages at the worst-case sensitive receptor

11.2.1.3 Process Emissions with Potential Odour

The existing Drehid WMF is currently licensed by the EPA (IED Licence number W0201-03), including the operation of a gas utilisation plant and 3 flares. There are not significant odour emissions from either of these processes.

The existing permission for the disposal of municipal solid waste has a predicted lifespan to 2028. Ongoing activities at the existing facility consist of the landfilling of waste materials in an MSW landfill at a maximum rate of 120,000 TPA and acceptance of suitable waste for composting in a Composting Facility at a maximum rate of 25,000 TPA. The engineered MSW landfill has a footprint area of approx. 39 ha and, when complete, will consist of 15 No. fully lined phases which are sub-divided into 3-6 separate cells (per phase) depending on the phase footprint area. BnM have been depositing waste in the MSW landfill since 2008 and the current status of landfilling activity at the facility is summarised as:

- Phases 1 to 4: Landfilling is complete and final capping has been put in place;
- Phases 5 to 11: Initial landfilling is complete and waste is being given time to self-compact. Temporary capping is in place;
- Phase 12: Current active phase and is accepting waste on a daily basis, the active working face area is 25 m^2 (as per IED Licence Conditions) with the rest of the phase under at least an interim capping; and
- Phases 13 -15: Construction of lined cells completed or under construction. No waste is deposited in these cells to date.

The composting facility is permitted to accept up to 25,000 TPA and has two biofilters which treat air prior to being vented from the building.

Table 11.3: Drehid Facility, County Kildare. Landfill Odour Emission Source Details

Activity Type	Municipal Solid Waste (ou m^{-2} s^{-1}) Note 1
Capped	0.10
Temp cap	0.67
Interim Cap	1.69
Active	6.17

Note 1: Odour emission rates (ou m^{-2} s^{-1}) taken from the 2012 and 2017 Drehid EIS/EIAR's.

Table 11.4: Drehid Facility, County Kildare. Composting Odour Emission Source Details

Stack Reference	Stack Height	Exit Diameter (m)	Temp (K)	Exit Velocity (m/sec actual)	Odour Conc. (OU_E/Nm^3) Note 1	Odour Mass Emission (g/s)
Composting Facility existing facility x 2	15	1.0	283	27.5	600	12500
Flare 1	8	2.3	1323	24.64	-	983
Flare 2	8	2.3	1338	21.23	-	983
Flare 3	10	1.5	1273	49.71	-	983

Note 1: Odour emission rates are based on upper limit of actual working detection for existing composting facility

11.2.2 Air Quality Assessment

11.2.2.1 Air Quality Standards

The air quality standards are applicable to both the air quality dispersion model (with respect to NO_x and particulate matter) and the traffic model. Air Quality standards are set for the protection of human health.

In order to reduce the risk to health from poor air quality, National and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values or "Air Quality Standards" are health or environmental-based levels for which additional factors may be considered. For example, natural background levels, environmental conditions and socio-economic factors may all play a part in the limit value which is set, see Table 11.5.

Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. The applicable standards in Ireland include the *Air Quality Standards Regulations 2011*, which incorporate *European Commission Directive 2008/50/EC* which has set limit values for the pollutants SO_2, NO_2, PM_{10}, benzene and CO, see Table 11.5. *Council Directive 2008/50/EC* combines the previous *Air Quality Framework Directive (96/62/EC)* and its subsequent daughter directives (including *1999/30/EC* and *2000/69/EC*). Provisions were also made for the inclusion of new ambient limit values relating to $PM_{2.5}$ (see Appendix 11.3).

Table 11.5: Air Quality Standards Regulations 2011 (based on EU Council Directive 2008/50/EC)

Pollutant	Regulation Note 1	Limit Type	Value
Nitrogen Dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	200 µg/m^3 NO_2
		Annual limit for protection of human health	40 µg/m^3 NO_2
		Critical level for protection of vegetation	30 µg/m^3 NO + NO_2
Lead	2008/50/EC	Annual limit for protection of human health	0.5 µg/m^3
Sulphur dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	350 µg/m^3
		Daily limit for protection of human health - not to be exceeded more than 3 times/year	125 µg/m^3
		Critical level for protection of vegetation	20 µg/m^3

Pollutant	Regulation Note 1	Limit Type	Value
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 µg/m^3 PM_{10}
		Annual limit for protection of human health	40 µg/m^3 PM_{10}
$PM_{2.5}$	2008/50/EC	Annual limit for protection of human health	25 µg/m^3 $PM_{2.5}$
Benzene	2008/50/EC	Annual limit for protection of human health	5 µg/m^3
Carbon Monoxide	2008/50/EC	8-hour limit (on a rolling basis) for protection of human health	10 mg/m^3 (8.6 ppm)

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

11.2.2.2 Climate

The UNFCCC is continuing detailed negotiations in relation to Greenhouse Gases (GHGs) reductions and in relation to technical issues such as Emission Trading and burden sharing. The most recent Conference of the Parties to the Convention (COP23) took place in Bonn, Germany from the 6th to the 17th of November 2017 and focussed on advancing the implementation of the Paris Agreement. The Paris Agreement was established at COP21 in Paris in 2015 and is an important milestone in terms of international climate change agreements. The "Paris Agreement", agreed by 200 nations, has a stated aim of limiting global temperature increases to no more than 2°C above pre-industrial levels with efforts to limit this rise to 1.5°C. The aim is to limit global GHG emissions to 40 gigatonnes as soon as possible whilst acknowledging that peaking of GHG emissions will take longer for developing countries. Contributions to greenhouse gas emissions will be based on Intended Nationally Determined Contributions (INDCs) which will form the foundation for climate action post 2020. Significant progress has also been made on elevating adaption onto the same level as action to cut and curb emissions.

The EU, on the 23/24th of October 2014, agreed the "2030 Climate and Energy Policy Framework" (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 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.

Gothenburg Protocol

In 1999, Ireland signed the Gothenburg Protocol to the 1979 UN Convention on Long Range Transboundary Air Pollution. The initial objective of the Protocol was to control and reduce emissions of Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_X), Volatile Organic Compounds (VOCs) and Ammonia (NH_3). To achieve the initial targets Ireland was obliged, by 2010, to meet national emission ceilings of 42 kt for SO_2 (67% below 2001 levels), 65 kt for NO_X (52% reduction), 55 kt for VOCs (37% reduction) and 116 kt for NH_3 (6% reduction). In 2012, the Gothenburg Protocol was revised to include national emission reduction commitments for the main air pollutants to be achieved in 2020 and beyond and to include emission reduction commitments for $PM_{2.5}$. In relation to Ireland, 2020 emission targets are 25 kt for SO_2 (65% on 2005 levels), 65 kt for NO_X (49% reduction on 2005 levels), 43 kt for VOCs (25% reduction on 2005 levels), 108 kt for NH_3 (1% reduction on 2005 levels) and 10 kt for $PM_{2.5}$ (18% reduction on 2005 levels).

European Commission Directive 2001/81/EC, the National Emissions Ceiling Directive (NECD) (2014), prescribes the same emission limits as the 1999 Gothenburg Protocol. A National Programme for the progressive reduction of emissions of these four transboundary pollutants has been in place since April 2005 (DEHLG, 2007a; 2004). Data available from the EU in 2010 indicated that Ireland complied with the emissions ceilings for SO_2, VOCs and NH_3 but failed to comply with the ceiling for NO_X (EEA, 2012). Directive (EU) 2016/2284 "*On the Reduction of National Emissions of Certain Atmospheric Pollutants and Amending Directive 2003/35/EC and Repealing Directive 2001/81/EC*" was published in December 2016. The Directive will apply the 2010 NECD limits until 2020 and establish new national emission reduction commitments which will be applicable from 2020 and 2030 for SO_2, NO_X, NMVOC, NH_3, $PM_{2.5}$ and CH_4. In relation to Ireland, 2020-29 emission targets are for SO_2 (65% below 2005 levels), for NO_X (49% reduction), for VOCs (25% reduction), for NH_3 (1% reduction) and for $PM_{2.5}$ (18% reduction). In relation to 2030, Ireland's emission targets are for SO_2 (85% below 2005 levels), for NO_X (69% reduction), for VOCs (32% reduction), for NH_3 (5% reduction) and for $PM_{2.5}$ (41% reduction).

11.2.2.3 Dispersion Modelling Methodology

Emissions from the site have been modelled using the AERMOD dispersion model (Version 18081) which has been developed by the U.S Environmental Protection Agency (USEPA) and the American Meteorological Society (AMS). The model is recommended as an appropriate model for assessing the impact of air emissions from industrial facilities in the EPA Guidance document "*Air Dispersion Modelling from Industrial Installations Guidance Note (AG4) (2010)*".

The model is a "new-generation" steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources. The model is an enhancement of the Industrial Source Complex-Short Term 3 (ISCST3) model which has been widely used for emissions from industrial sources. Details of the model are given in Appendix 11.1. Fundamentally, the model has made significant advances in simulating the dispersion process in the boundary layer. This will lead to a more accurate

reflection of real world processes and thus considerably enhance the reliability and accuracy of the model particularly under those scenarios which give rise to the highest ambient concentrations.

The United States Environmental Protection Agency (USEPA) approved AERMOD dispersion model has been used to predict the ground level odour concentrations (GLC) of compounds emitted from the principal emission sources on-site.

The modelling incorporated the following features:

- Two receptor grids were created at which concentrations would be modelled. Receptors were mapped with sufficient resolution to ensure all localised “hot-spots” were identified without adding unduly to processing time. The receptor grids were based on Cartesian grids with the site at the centre. An outer grid extended to 10,000 m^2 with the site at the centre and with concentrations calculated at 100 m intervals. A smaller denser grid extended to 4,500 m^2 from the site with concentrations calculated at 50 m intervals. Boundary receptor locations were also placed along the boundary of the site, at 25 m intervals, giving over 18,400 calculation points for the model as shown in Figure 11.3.
- All on-site buildings and significant process structures were mapped into the computer to create a three dimensional visualisation of the site and its emission points. Buildings and process structures can influence the passage of airflow over the emission stacks and draw plumes down towards the ground (termed building downwash). The stacks themselves can influence airflow in the same way as buildings by causing low pressure regions behind them (termed stack tip downwash). Both building and stack tip downwash were incorporated into the modelling.
- Detailed terrain has been mapped into the model using SRTM data with 30 m resolution. The site is located in gentle terrain. This takes account of all significant features of the terrain. All terrain features have been mapped in detail into the model using the terrain pre-processor AERMAP (USEPA 2004b) as shown in Figure 11.4.
- Hourly-sequenced meteorological information has been used in the model. Meteorological data over a five year period (Casement Aerodrome, 2013–2017) was used in the model (see Figure 11.2).
- The source and emission data, including stack dimensions, gas volumes and emission temperatures have been incorporated into the model.

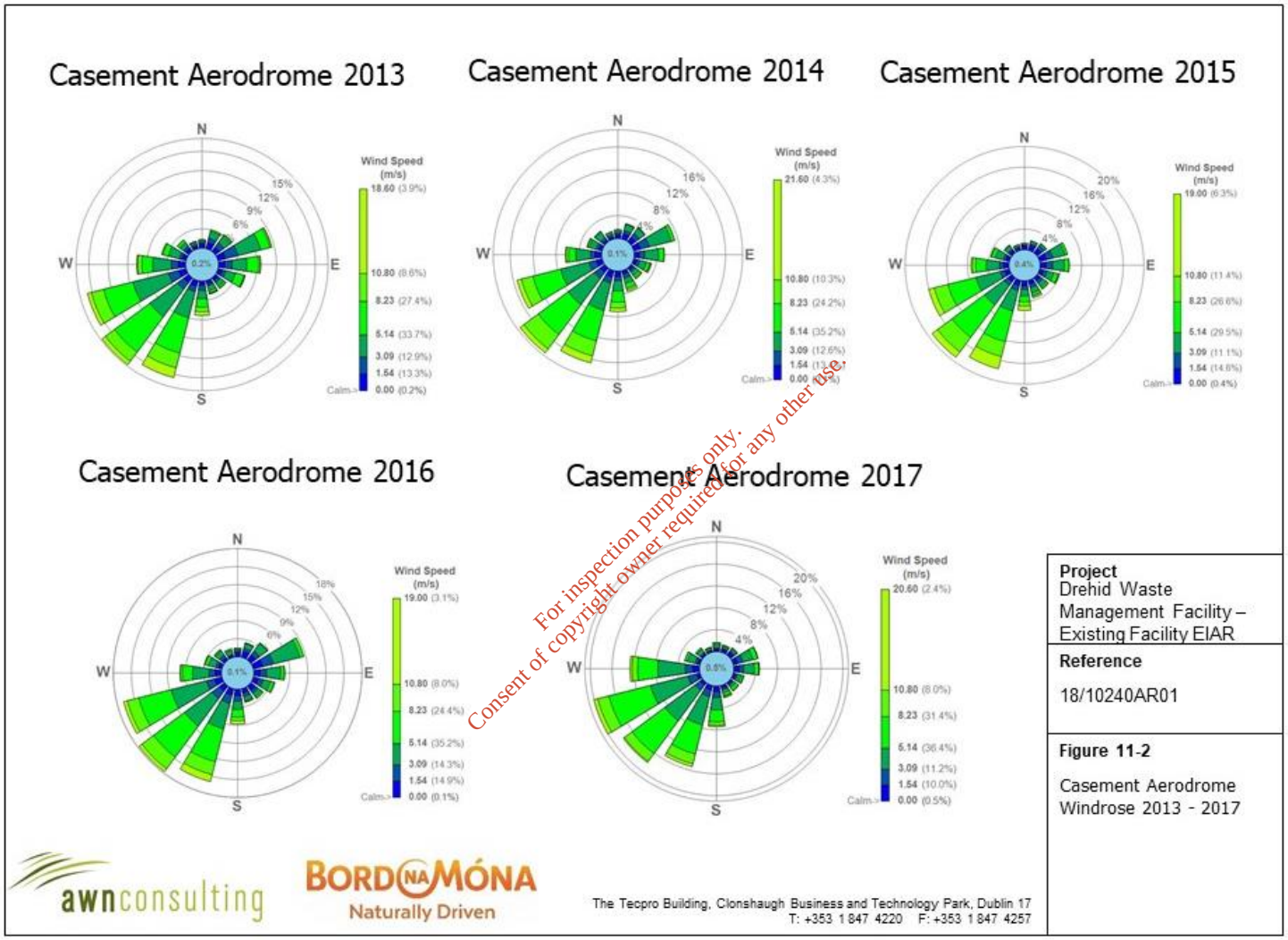


Figure 11.2: Casement Aerodrome Windrose 2013-2017

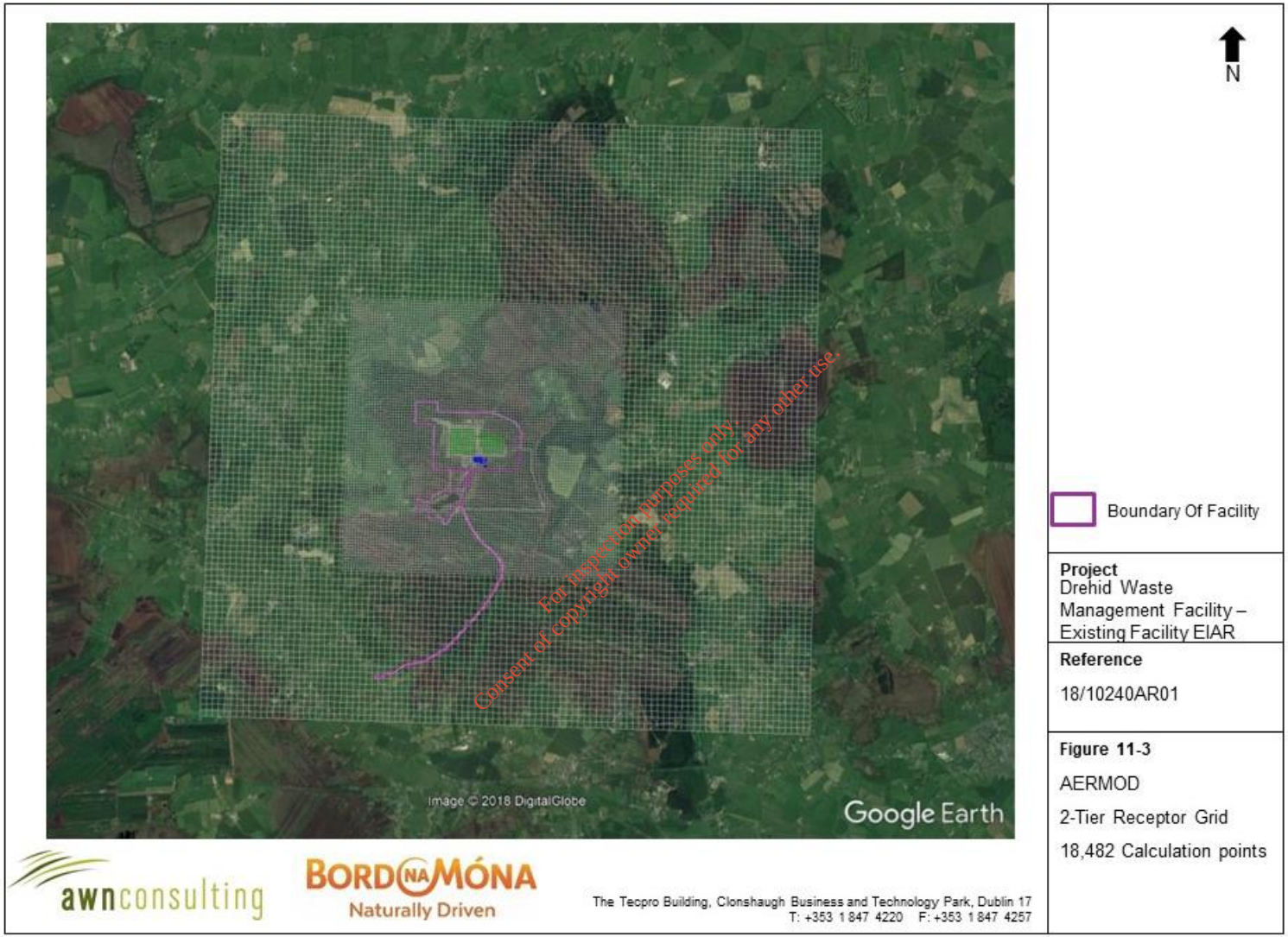


Figure 11.3: AERMOD 2-Tier Receptor Grid

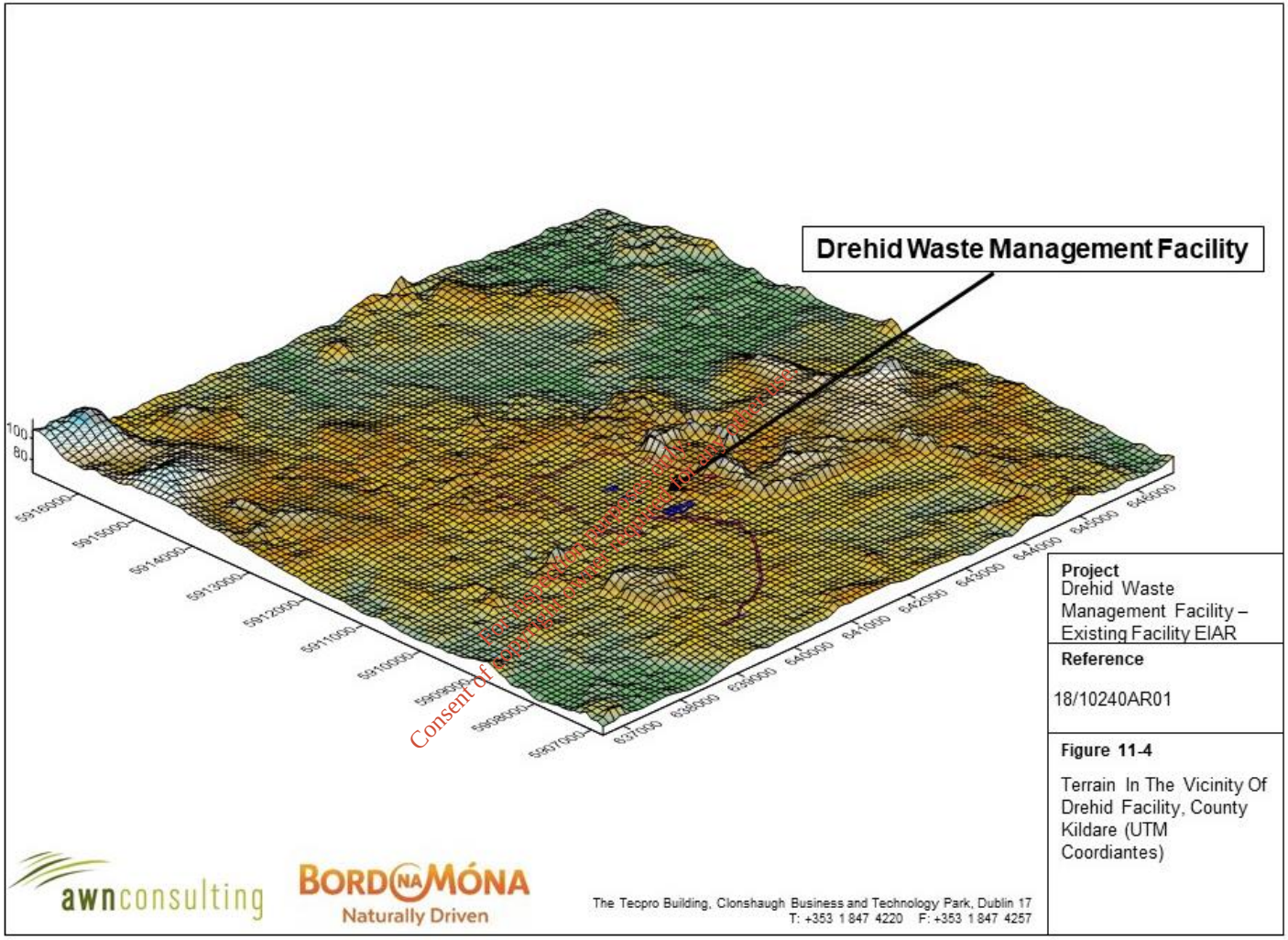


Figure 11.4: Terrain in the Vicinity of Drehid Facility (UTM Coordinates)

Terrain

The AERMOD air dispersion model has a terrain pre-processor AERMAP (USEPA 2004b) which was used to map the physical environment in detail over the receptor grid. The digital terrain input data used in the AERMAP pre-processor was obtained from SRTM. This data was run to obtain for each receptor point the terrain height and the terrain height scale. The terrain height scale is used in AERMOD to calculate the critical dividing streamline height, H_{crit}, for each receptor. The terrain height scale is derived from the Digital Elevation Model (DEM) files in AERMAP by computing the relief height of the DEM point relative to the height of the receptor and determining the slope. If the slope is less than 10%, the program goes to the next DEM point. If the slope is 10% or greater, the controlling hill height is updated if it is higher than the stored hill height.

In areas of complex terrain, AERMOD models the impact of terrain using the concept of the dividing streamline (H_c). As outlined in the AERMOD model formulation (USEPA 2004a) a plume embedded in the flow below H_c tends to remain horizontal; it might go around the hill or impact on it. A plume above H_c will ride over the hill. Associated with this is a tendency for the plume to be depressed toward the terrain surface, for the flow to speed up, and for vertical turbulent intensities to increase.

AERMOD model formulation states that the model "captures the effect of flow above and below the dividing streamline by weighting the plume concentration associated with two possible extreme states of the boundary layer (horizontal plume and terrain-following). The relative weighting of the two states depends on the following; 1) the degree of atmospheric stability; 2) the wind speed; and 3) the plume height relative to terrain. In stable conditions, the horizontal plume "dominates" and is given greater weight while in neutral and unstable conditions, the plume travelling over the terrain is more heavily weighted (USEPA 2004a). The terrain in the region of the facility is reasonably flat however, in general, as shown in Figure 11.4.

Geophysical Considerations

AERMOD simulates the dispersion process using planetary boundary layer (PBL) scaling theory (USEPA 2004a). PBL depth and the dispersion of pollutants within this layer are influenced by specific surface characteristics such as surface roughness, albedo and the availability of surface moisture. Surface roughness is a measure of the aerodynamic roughness of the surface and is related to the height of the roughness element. Albedo is a measure of the reflectivity of the surface whilst the Bowen ratio is a measure of the availability of surface moisture.

AERMOD incorporates a meteorological pre-processor AERMET PRO (USEPA 2004c) to enable the calculation of the appropriate parameters. The AERMET PRO meteorological pre-processor requires the input of surface characteristics, including surface roughness (z0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated

land etc) and vary with seasons and wind direction. The assessment of appropriate land-use type was carried out to a distance of 10 km from the meteorological station for Bowen Ratio and albedo and to a distance of 1 km for surface roughness in line with USEPA recommendations (USEPA 2004c, 2008) as outlined in Appendix 11.2.

In relation to AERMOD, detailed guidance has been published (Alaska Department of Environmental Conservation 2008) for calculating the relevant surface parameters. The most pertinent features are the following;

- The surface characteristics should be those of the meteorological site (Casement Airport) rather than the installation;
- Surface roughness should use a default 1 km radius upwind of the meteorological tower and should be based on an inverse-distance weighted geometric mean. If land use varies around the site, the land use should be sub-divided by sectors with a minimum sector size of 30º; and
- Bowen ratio and albedo should be based on a 10 km grid. The Bowen ratio should be based on an un-weighted geometric mean. The albedo should be based on a simple un-weighted arithmetic mean.

AERMOD has an associated pre-processor, AERSURFACE (USEPA 2008), which has representative values for these parameters depending on land use type. The AERSURFACE pre-processor currently only accepts NLCD92 land use data which covers the USA. Thus, manual input of surface parameters is necessary when modelling in Ireland. Ordnance survey discovery maps (1:50,000) and digital maps such as those provided by the EPA, National Parks and Wildlife Service (NPWS) and Google Earth® are useful in determining the relevant land use in the region of the meteorological station. The Alaska Department of Environmental Conservation has issued a guidance note for the manual calculation of geometric mean for surface roughness and Bowen ratio for use in AERMET (Alaska Department of Environmental Conservation 2008). This approach has been applied to the current site with full details provided in Appendix 11.2.

Building Downwash

When modelling emissions from an industrial installation, stacks which are relatively short can be subjected to additional turbulence due to the presence of nearby buildings. Buildings are considered nearby if they are within five times the lesser of the building height or maximum projected building width (but not greater than 800 m).

The USEPA has defined the “Good Engineering Practice” (GEP) stack height as the building height plus 1.5 times the lesser of the building height or maximum projected building width. It is generally considered unlikely that building downwash will occur when stacks are at or greater than GEP (USEPA 1985).

When stacks are less than this height, building downwash will tend to occur. As the wind approaches a building it is forced upwards and around the building leading to the formation of turbulent eddies. In the lee of the building these eddies will lead to downward mixing (reduced plume centreline and reduced plume rise) and the creation of a cavity zone (near wake) where re-circulation of the air can occur. Plumes released from short stacks may be entrained in this airflow leading to higher ground level concentrations than in the absence of the building.

The Plume Rise Model Enhancements (PRIME) (Paine, R & Lew, F. 2010, Schulman, L.L et al 2000) plume rise and building downwash algorithms, calculate the impact of buildings on plume rise and dispersion, and have been incorporated into AERMOD. The building input processor BPIP-PRIME produces the parameters which are required in order to run PRIME. The model takes into account the position of each stack relative to each relevant building and the projected shape of each building for 36 wind directions (at 10º intervals). The model determines the change in plume centreline location with downwind distance based on the slope of the mean streamlines and coupled to a numerical plume rise model (Paine, R & Lew, F. 2010).

Given that most stacks onsite are less than 2.5 times the lesser of the building height or maximum projected building width, building downwash will need to be taken into account and the PRIME algorithm run prior to modelling with AERMOD. The dominant building may change as the wind direction changes for each of the 36 wind directions. The dominant building for each relevant stack will vary as a function of wind direction and relative building heights.

Construction Phase Dust

The greatest potential impact on air quality during the occasional construction works aimed at increasing the landfill capacity (this will include construction of phases 14 and 15) is from construction dust emissions and the potential for nuisance dust and PM_{10}/$PM_{2.5}$ emissions. While construction dust tends to be deposited within 200 m of a construction site, the majority of the deposition occurs within the first 50 m. The large site and long entrance drive ensure that there are no sensitive residential receptors within 200 m of the construction area.

Air Quality Process Emissions

The Drehid facility is currently licensed (IED Licence numbers W0201-03) including the operation of a gas utilisation plant and flares. The site has three flares which are assumed to run continuously, two of which are associated with the gas utilisation plant. Flare monitoring reports from 2015, 2016 and 2017 indicate that the flares are below the licensed limit under W0201-03, which sets a limit value for NO_x of 150 mg/m^3. The flares have been modelled as being in continuous operation as a worst-case scenario; however, this is unlikely to be the case.

On site there is also the capture and utilisation of the landfill gas for the generation of electricity for supply to the national grid. As part of the utilisation plant there are four gas engines. These engines are licensed to discharge NO_x and particulates under W0201-03, see Table 11.9 for details.

Table 11.6: Drehid Facility, County Kildare. Landfill NOx and PM_{10} Emission Source Details

Emission Source Reference	Exit Diameter (m)	Temp (K)	Max Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual, wet)	NO_2		PM_{10}	
					Concentration (mg/Nm^3)	Mass Emission (g/s)	Concentration (mg/Nm^3)	Mass Emission (g/s)
Gas Utilisation Plant 1	0.4	733	3,497	28.14	500	0.49	130	0.13
Gas Utilisation Plant 2	0.4	744	3,388	27.0	500	0.47	130	0.12
Gas Utilisation Plant 3	0.4	738	3,563	28.11	500	0.49	130	0.13
Gas Utilisation Plant 4	0.4	746	3,523	28.27	500	0.49	130	0.13
Flare 1	2.3	1323	36,350	24.64	150	1.51	N/A	N/A
Flare 2	2.3	1338	36,350	21.23	150	1.51	N/A	N/A
Flare 3	1.5	1273	29,080	49.71	150	1.21	N/A	N/A

11.2.2.4 Traffic Assessment

The air quality assessment was carried out following procedures described in the publications by the EPA (EPA 2015 and TII 2011) and using the methodology outlined in the policy and technical guidance notes, LAQM.PG(16) and LAQM.TG(16), issued by UK DEFRA (Department for Environment, Food and Rural Affairs) (UK DEFRA 2001, 2009a, 2009b; UK DETR 1998, UK Highways Agency 2007). The assessment of air quality is carried out using a phased approach as recommended by the UK DEFRA (UK DEFRA 2016). The phased approach recommends that the complexity of an air quality assessment be consistent with the risk of failing to achieve the air quality standards. In the current assessment, an initial scoping of key pollutants was carried out at sensitive receptors. These sensitive receptors have the potential to have an impact on the concentration of key pollutants due to the existing facility.

An examination of recent EPA and Local Authority data in Ireland (EPA 2016, 2017), has indicated that SO_2 and CO are unlikely to be exceeded at locations such as the current one and thus these pollutants do not require detailed monitoring or assessment to be carried out. However, the analysis did indicate potential problems in regards to nitrogen dioxide (NO_2) and PM_{10} at busy junctions in urban centres (EPA 2016, 2017). Benzene, although previously reported at quite high levels in urban centres (EPA 2016, 2017), has recently been measured at several city centre locations to be well below the EU limit value (EPA 2016, 2017). Historically, CO levels in urban areas were a cause for concern. However, CO concentrations have decreased significantly over the past number of years and are now measured to be well below the limits even in urban centres (EPA 2016, 2017). The key pollutants reviewed in the assessment are NO_2, PM_{10}, $PM_{2.5}$, benzene and CO, with particular focus on NO_2 and PM_{10}.

The assessment methodology involved air dispersion modelling using the UK DMRB Screening Model (UK Highways Agency 2007) (Version 1.03c, July 2007), the NO_x to NO_2 Conversion Spreadsheet (UK DEFRA, 2016) (Version 5.1), and following guidance issued by the TII (TII 2011), UK Highways Agency (UK Highways Agency 2007), UK DEFRA (UK DEFRA 2016a) and the EPA (EPA 2016, 2017).

The TII guidance (TII, 2011) states that the assessment must progress to detailed modelling if:

- Concentrations exceed 90% of the air quality limit values when assessed by the screening method; or
- Sensitive receptors exist within 50 m of a complex road layout (e.g. grade separated junctions, hills etc).

The UK DMRB guidance (UK Highways Agency 2007), on which the TII guidance was based, states that road links meeting one or more of the following criteria can be defined as being ‘affected’ by a proposed development and should be included in the local air quality assessment:

- Road alignment change of 5 metres or more;
- Daily traffic flow changes by 1,000 AADT or more;
- HDV flows change by 200 vehicles per day or more;

- Daily average speed changes by 10 km/h or more; or
- Peak hour speed changes by 20 km/h or more.

Concentrations of key pollutants were calculated at sensitive receptors which have the potential to be affected by the existing facility. For road links which are deemed to be affected by the existing facility and within 200 m of the chosen sensitive receptors inputs to the air dispersion model consist of; road layouts, receptor locations, annual average daily traffic movements (AADT), percentage heavy goods vehicles, annual average traffic speeds and background concentrations. The UK DMRB guidance states that road links at a distance of greater than 200 m from a sensitive receptor will not influence pollutant concentrations at the receptor.

Using this input data, the model predicts the road traffic contribution to ambient ground level concentrations at the worst-case sensitive receptors using generic meteorological data. The DMRB model uses conservative emission factors, the formulae for which are outlined in the DMRB Volume 11 Section 3 Part 1 – HA 207/07 Annexes B3 and B4. These worst-case road contributions are then added to the existing background concentrations to give the worst-case predicted ambient concentrations. The worst-case ambient concentrations are then compared with the relevant ambient air quality standards to assess the compliance of the existing facility with these ambient air quality standards.

The TII *Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes* (TII 2011) detail a methodology for determining air quality impact significance criteria for road schemes. The degree of impact is determined based on both the absolute and relative impact. The TII significance criteria have been adopted for the existing facility and are detailed in Table 11.10 to Table 11.12. The significance criteria are based on PM_{10} and NO_2 as these pollutants are most likely to exceed the annual mean limit values (40 µg/m^3). However, the criteria have also been applied to the predicted 8-hour CO, annual benzene and annual $PM_{2.5}$ concentrations for the purposes of this assessment.

Table 11.7: Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations

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

Source: Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes - Transport Infrastructure Ireland (2011)

Table 11.8: Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations

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

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

Source: Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes - Transport Infrastructure Ireland (2011)

Table 11.9: Air Quality Impact Significance Criteria for PM_{10}

Absolute Concentration in Relation to Objective / Limit Value (PM_{10})	Change in Concentration		
	Small	Medium	Large
Increase with Scheme			
Above Objective/Limit Value With Scheme (≥35 days)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value With Scheme (32 - <35 days)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value With Scheme (26 - <32 days)	Negligible	Slight Adverse	Slight Adverse

Absolute Concentration in Relation to Objective / Limit Value (PM_{10})	Change in Concentration		
	Small	Medium	Large
Well Below Objective/Limit Value With Scheme (<26 days)	Negligible	Negligible	Slight Adverse
Decrease with Scheme			
Above Objective/Limit Value With Scheme (≥35 days)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value With Scheme (32 - <35 days)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value With Scheme (26 - <32 days)	Negligible	Slight Beneficial	Slight Beneficial
Well Below Objective/Limit Value With Scheme (<26 days)	Negligible	Negligible	Slight Beneficial

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

Source: Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes - Transport Infrastructure Ireland (2011)

Ecological Sites

For routes which pass within 2 km of a designated area of conservation (either Irish or European designation) the TII requires consultation with an Ecologist (TII, 2011). However, in practice the potential for impact to an ecological site is highest within 200 m of the existing facility and when significant changes in AADT (>5%) occur.

TII's Guidelines for Assessment of Ecological Impacts of National Road Schemes (Rev. 2, Transport Infrastructure Ireland 2009) and Appropriate Assessment of Plans and Projects in Ireland – Guidance for Planning Authorities (Department of the Environment, Heritage and Local Government 2010) provide details regarding the legal protection of designated conservation areas.

If the two following assessment criteria are met, an assessment of the potential for impact due to nitrogen deposition should be assessed; a designated area of conservation within 200 m of the existing facility and a significant change in AADT flows. There are no designated areas of conservation within 200 m from the site.

Traffic Model Inputs

The impact of traffic emissions due to the existing development on local air quality can be assessed using the DMRB methodology. Traffic assessments show that in the region of 33 no. HGVS and 17 cars movement per day on local public roads are associated with the existing facility. For construction (assuming one of the landfill phases is constructed during 2019), there will be an additional 8 no. HGVs and 27 no. cars daily (one-way). C. 6 months for construction of the landfill phase. The future activities of

the development is such that there is no change in predicted impact on traffic, beneficial or adverse. Detailed in the DMRB guidance, a quantitate air quality assessment is required under the following circumstances:

- Road alignment change of 5 metres or more;
- Daily traffic flow changes by 1,000 AADT or more;
- HGVs flows change by 200 vehicles per day or more;
- Daily average speed changes by 10 km/h or more; or
- Peak hour speed changes by 20 km/h or more.

Therefore, using the DMRB screening criteria, no road links can be classed as 'affected' by the existing development's and do not require inclusion in the local air quality assessment.

11.3 RECEIVING ENVIRONMENT

11.3.1 Meteorological Data

The selection of the appropriate meteorological data has followed the guidance issued by the USEPA (USEPA, 2005). A primary requirement is that the data used should have a data capture of greater than 90% for all parameters.

A key factor in assessing temporal and spatial variations in the air quality assessment is the prevailing meteorological conditions. Depending on wind speed and direction, individual receptors may experience very significant variations in pollutant levels under the same source strength (e.g. traffic levels) (WHO, 2006).

Wind is of key importance in dispersing air pollutants and for ground level sources, such as traffic emissions, pollutant concentrations are generally inversely related to wind speed. Thus, concentrations of pollutants 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.

Casement Aerodrome meteorological station, which is located approximately 30 km east of the site, collects data in the correct format and has data capture collection of greater than 90% for the required parameters. Long-term hourly observations at Casement Aerodrome meteorological station provide an indication of the prevailing wind conditions for the region (see Figure 11.2). Results indicate that the prevailing wind direction is from a southerly to westerly in direction over the period 2013-2017. The mean wind speed is approximately 5.5 m/s over the period 1981-2010.

11.3.2 Background Concentrations of Pollutants

Air quality monitoring programs have been undertaken in recent years by the EPA and Local Authorities (EPA 2018, 2017). The most recent annual report on air quality "Air Quality Monitoring Annual Report 2016" (EPA 2017), details the range and scope of monitoring undertaken throughout Ireland. As part of the implementation of the Framework Directive on Air Quality (1996/62/EC), four air quality zones have been defined in Ireland for air quality management and assessment purposes (EPA 2017). Dublin is defined as Zone A and Cork as Zone B. Zone C is composed of 23 towns with a population of greater than 15,000. The remainder of the country, which represents rural Ireland but also includes all towns with a population of less than 15,000, is defined as Zone D. In terms of air monitoring, the area of the facility is categorised as Zone D (EPA 2017).

NO_2 monitoring was carried out at two rural Zone D locations in 2016, Emo and Kilkitt and in two urban areas, Enniscorthy and Castlebar (EPA 2017). The NO_2 annual average in 2016 for both rural sites was 2.5 µg/m^3 with the results for urban stations averaging 8.5 µg/m^3. Hence long-term average concentrations measured at all locations were significantly lower than the annual average limit value of 40 µg/m^3. The average results over the last five years at a range of urban Zone D locations suggests an upper average of no more than 11 µg/m^3 as a background concentration as shown in Table 11.6. Local diffusion tube monitoring results for NO_2 in November 2011 ranged from 5.5 – 12.9 µg/m^3. Given that background NO_2 concentrations have reduced in the past 6 years a conservative estimate of the background NO_2 concentration in the region of the facility is 11 µg/m^3.

Table 11.10: Annual Mean NO_2 Concentrations In Zone D Locations 2013 - 2016 (µg/m^3)

Year	Enniscorthy	Kilkitt	Emo	Castlebar
2012	-	4	-	8
2013	-	4	4	11
2014	13	3	3	8
2015	9	2	3	8
2016	9	2	3	8
Average	11	3.2	3.3	8.6

Long-term PM_{10} monitoring was carried out at the urban Zone D locations of Castlebar, Kilkitt, Enniscorthy and Claremorris in 2016 (EPA 2017). The maximum 24-hour concentration (as a 90th%ile) at each of the Zone D locations is shown in Table 11.7. The long-term average of the 90th%ile of 24-hour concentration is 23.1 µg/m^3. The average annual mean concentration measured is 13.4 µg/m^3 (EPA 2016). The average results over the last five years at a range of Zone D locations suggests an upper average of 13.4 µg/m^3 as a background concentration as shown in Table 11.8. However, data monitored on site by AWN between June – August 2016 shows that the actual concentrations are lower.

Table 11.11: 90th%ile of 24-Hour PM_{10} Concentrations In Zone D Locations 2013 - 2016 (µg/m³)

Year	Claremorris	Kilkitt	Enniscorthy	Castlebar
2013	21.0	18.6	-	26.9
2014	15.2	15.4	37.35	20.9
2015	16.4	18.0	33.8	22.1
2016	20.0	15.0	32.3	20.0
Average	**18.8**	**16.6**	**34.8**	**22.9**

Table 11.12: Annual Mean PM_{10} Concentrations In Zone D Locations 2013 - 2016 (µg/m³)

Year	Claremorris	Kilkitt	Enniscorthy	Castlebar
2013	10	9	-	12
2014	13	11	-	15
2015	10	9	22	12
2016	10	9	18	13
Average	11.0	9.4	20.0	13.2

The results of $PM_{2.5}$ monitoring at Claremorris (Zone D) in 2016 (EPA 2017) indicated an average $PM_{2.5}/PM_{10}$ ratio of 0.6. Based on this information, a conservative ratio of 0.6 was used to generate a rural background $PM_{2.5}$ concentration of 8.0 µg/m³.

A baseline monitoring study was carried on the current Drehid Landfill Site, close to the administration building from June to August 2016. The results of the survey allow a comparison with the annual limit values for PM_{10}, and the 24-hour limit value for PM_{10}. The results also provide information on the influence of road sources relative to the prevailing background level of these pollutants in the area.

The PM_{10} & $PM_{2.5}$ monitoring program was carried out by means of Turnkey Instruments® Osiris Environmental Dust Monitor at one location. The Osiris instrument is a light scattering device capable of continuous measurement of Total Suspended Particulate (TSP), PM_{10}, $PM_{2.5}$ and PM_1. The air sample was continuously drawn into the instrument by a pump through a heated inlet at a flow rate of 600 ml/min. The incoming air passed through a laser beam in a photometer. The light scattered by the individual particles of dust was measured by the photometer and this information used to measure the size and concentration of the dust particles.

The average PM_{10} concentration measured over the monitoring period is 8.6 µg/m³ using the Osiris light scattering monitor. The average concentration is less than 22% of the EU annual limit value of 40 µg/m³.

The average $PM_{2.5}$ concentration measured over the two month monitoring period is significantly below the annual EU limit value of 25 μg/m^3. The average $PM_{2.5}$ concentration measured over the one-month period is 3.0 μg/m^3 which is significantly below the annual average EU limit value of 25 μg/m^3.

CO concentrations for the representative rural Zone D monitoring stations are between 2013 and 2016 on average 0.4 mg/m^3 for the 8-hour value. This is significantly below the 10 mg/m^3 limit value.

In terms of benzene, there are no Zone D monitoring stations however the average annual mean concentration in the Zone C locations of Mullingar and Kilkenny for 2013 to 2016 was 0.23 µg/m^3. This is well below the limit value of 5 µg/m^3 (EPA 2016). 2013 to 2016 annual mean concentrations ranged from 0.09 – 0.5 µg/m^3. Based on this EPA data, a conservative estimate of the background benzene concentration in Drehid is 0.5 µg/m^3.

In relation to the annual averages, the ambient background concentration is added directly to the process concentration. However, in relation to the short-term peaks, concentrations due to emissions from elevated sources cannot be combined in the same way. Guidance from the UK DEFRA (UK DEFRA 2016a) and the EPA (EPA 2010) advises that for PM_{10} and NO_2 an estimate of the maximum combined pollutant concentration can be obtained as shown below:

PM_{10} - The 90.4th%ile of total 24-hour mean PM_{10} is equal to the maximum of either A or B below:

a) 90.4th%ile of 24-hour mean background PM_{10} + annual mean process contribution PM_{10}

b) 90.4th%ile 24-hour mean process contribution PM_{10} + annual mean background PM_{10}

NO_2 - The 99.8th%ile of total NO_2 is equal to the minimum of either A or B below:

a) 99.8th%ile hourly background total oxidant (O_3 & NO_2) + 0.05 x (99.8th%ile process contribution NO_X)

The maximum of either:

a) 99.8th%ile process contribution NO_X + 2 x (annual mean background NO_2); or

b) 99.8th%ile hourly background NO_2 + 2 x (annual mean process contribution NO_X).

In relation to the annual averages, the ambient background concentration was added directly to the process concentration with the short-term peaks calculated using the equations above.

11.4 POTENTIAL EFFECTS

11.4.1 Odour Emissions

Details of the 98th%ile of 1-hour mean odour concentrations at the worst case receptor are given in Table 11.13 over a five-year period (2013-2017) based on the USEPA approved AERMOD model (version 18081).

Table 11.14 shows the worst cases of the closest sensitive receptors to the site. The maximum 1-hour 98th%ile odour concentration at the worst case sensitive receptor is 2.43 OU_E/m^3. This is equivalent to 81% of the relevant odour criterion of 3.0 OU_E/m^3 measured as a 98th%ile of mean hourly odour concentrations at the worst case receptor.

It should be noted that concentrations less than 3.0 Ou_E/m^3 are not shown on Figure 11.5 because it was not considered necessary as they are below the ambient odour criterion of 3.0 Ou_E/m^3.

Table 11.13: Predicted Odour Concentration At Worst-Case Offsite Receptor (OUE/m^3)

Model Scenario / Meteorological Year	Averaging Period	Predicted Odour Concentration (OU_E/m^3)[Note 1]	Guideline (OU_E/m^3)
			EPA AG4 (2010)
Ambient Odour Concentration / 2013	Maximum 1-Hour (as a 98th%ile)	2.29	3.0 (UK Guidance)
Ambient Odour Concentration / 2014		2.11	
Ambient Odour Concentration / 2015		1.76	
Ambient Odour Concentration / 2016		2.43	
Ambient Odour Concentration / 2017		2.08	

Table 11.14: Predicted Odour Concentration At Closest Sensitive Receptors (OUE/m^3)

Sensitive Receptor Grid Co-ordinates UTM (Zone 29 N)		Maximum 1-Hour 98th%ile Predicted Odour Conc. (OU_E/m^3)				
		2013	2014	2015	2016	2017
642600.8	5911907	2.02	1.52	1.45	1.83	1.88
642189.4	5912274	2.27	2.11	1.72	2.43	2.08
642374.2	5912133	2.14	1.82	1.37	2.07	1.66
642561.8	5911993	2.29	1.64	1.36	2.02	1.98

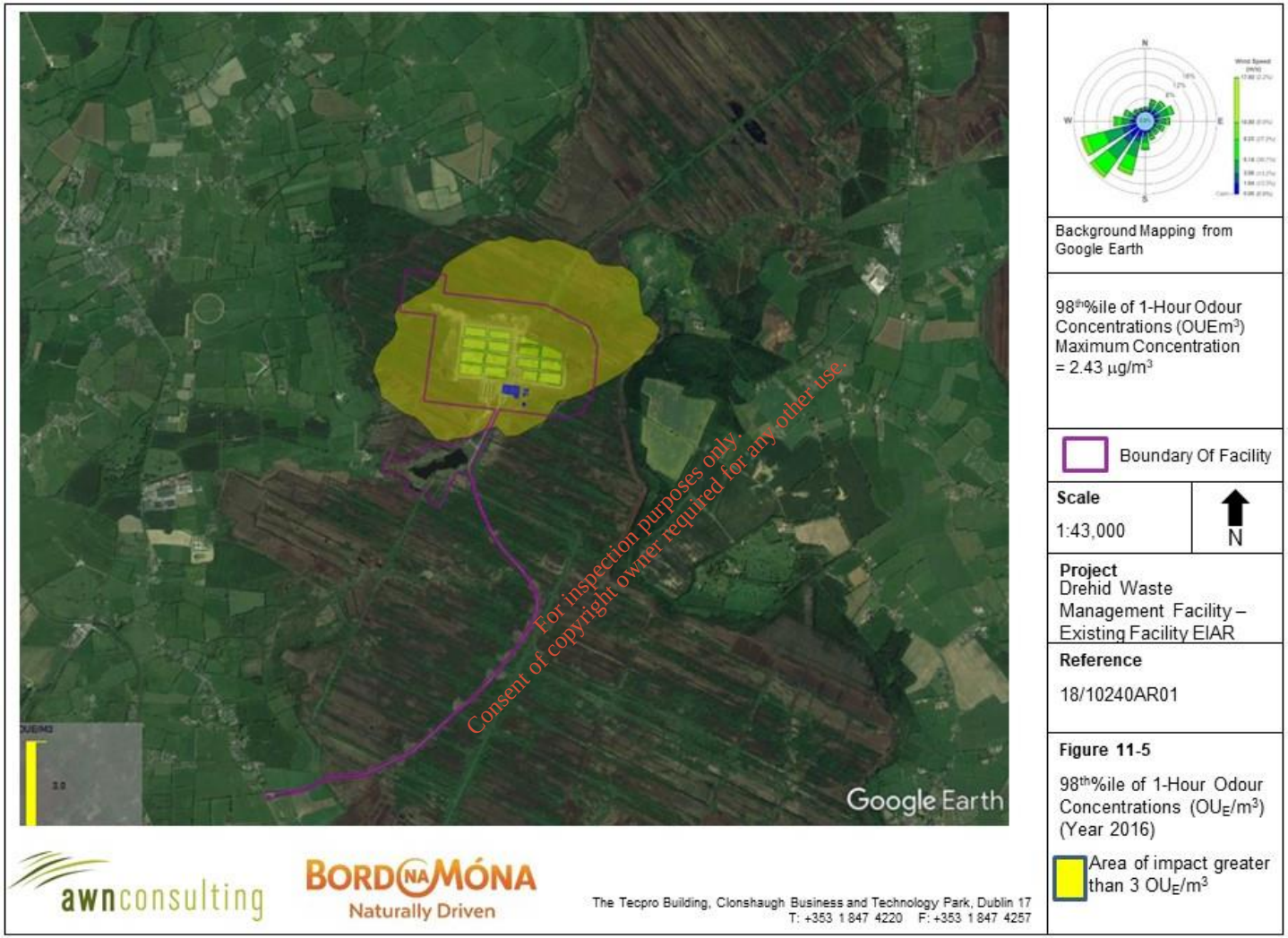


Figure 11.5: 98th% of 1-Hour Odour Concentrations (OU_E/m^3) (Year 2016)

11.4.2 NOx and Particulate Matter Dispersion Modelling

11.4.2.1 NOx

The NO_2 modelling results are detailed in Table 11.15. The results indicate that the ambient ground level concentrations at the worst-case ground level location are significantly below the relevant air quality standards for NO_2. Cumulative emissions from the gas utilisation plant and flares lead to an ambient NO_2 concentration (including background) which is 21.4% of the maximum ambient 1-hour limit value (measured as a 99.8th%ile) and 34.4% of the annual limit value at the worst-case off site location (see Figure 11.6).

Table 11.15: Dispersion Model Results– NO_2

Pollutant/ Meteorological year	Background (µg/m^3)	Averaging Period	NO_2 Process Contribution (µg/m^3)	NO_2 Predicted Environmental Concentration (PEC) (µg/Nm^3)	Standard (µg/Nm^3) *Note 1*
NO_2 / 2013	N/A	99.8th%ile of 1-hr means	19.4	41.3	200
	11	Annual Mean	2.1	13.1	40
NO_2 / 2014	N/A	99.8th%ile of 1-hr means	19.8	41.7	200
	11	Annual Mean	2.3	13.3	40
NO_2 / 2015	N/A	99.8th%ile of 1-hr means	20.8	42.7	200
	11	Annual Mean	2.7	13.7	40
NO_2 / 2016	N/A	99.8th%ile of 1-hr means	19.5	41.4	200
	11	Annual Mean	2.1	13.1	40
NO_2 / 2017	N/A	99.8th%ile of 1-hr means	19.5	41.5	200
	11	Annual Mean	2.3	13.3	40

Note 1 Air Quality Standards 2011 (from EU Directive 2008/50/EC)

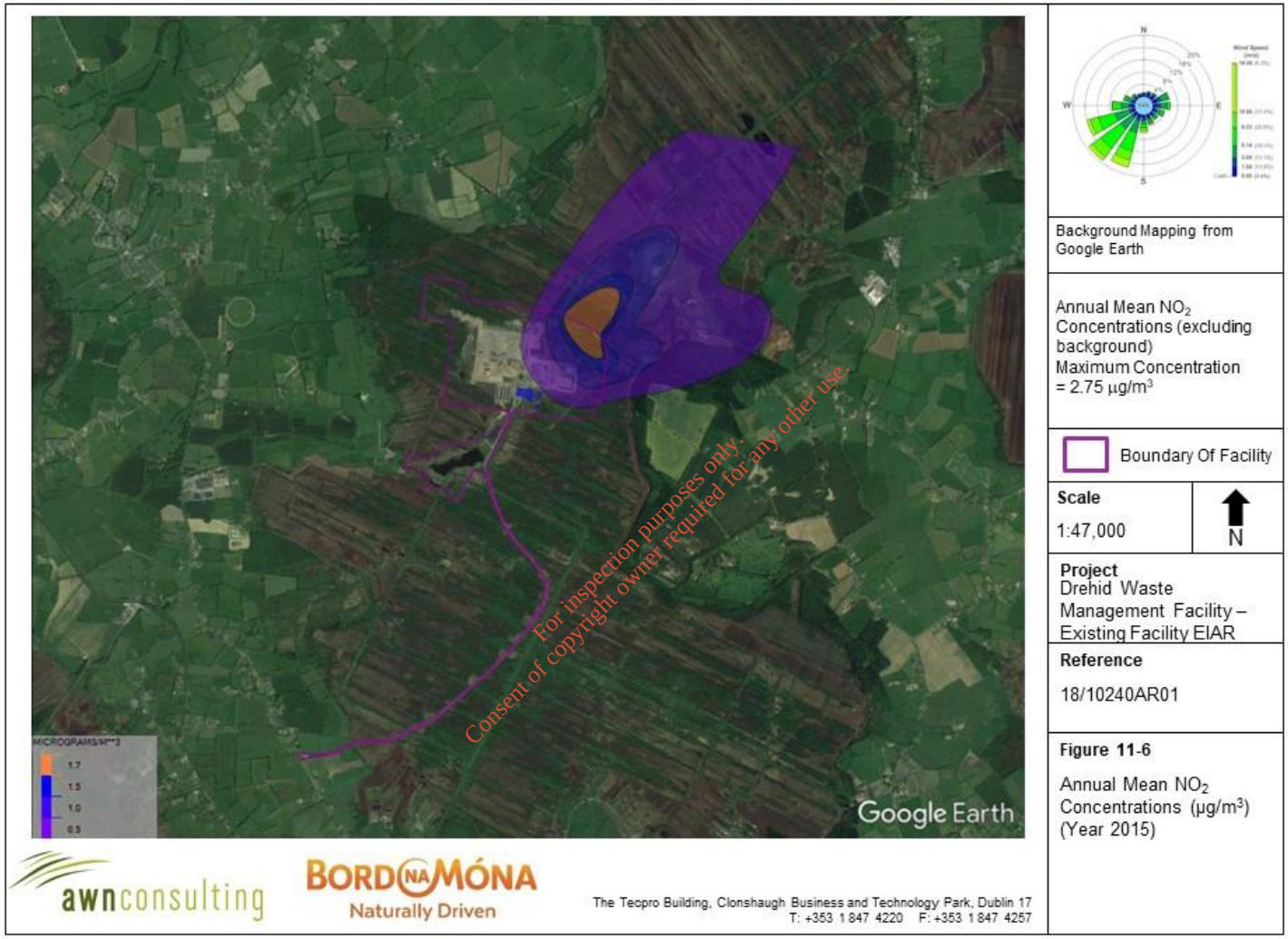


Figure 11.6: Annual Mean NO_2 Concentrations (µg/m3) (Year 2015)

11.4.2.2 Particulate Matter

The PM_{10} / $PM_{2.5}$ modelling results are detailed in Table 11.16 and Table 11.17. The results indicate that the ambient ground level concentration is below the relevant air quality standard for PM_{10} / $PM_{2.5}$. Cumulative emissions from the gas utilisation plant dust filter lead to an ambient PM_{10} concentration (including background) which is 38% of the maximum ambient 24-hour limit value at the worst-case off site location (see Table 11.16 and Figure 11.7). In relation to the annual mean concentration, ambient PM_{10} / $PM_{2.5}$ concentration (including background) are at most 23% of the annual mean limit values at the worst-case off site location (see Table 11.17). At the worst case off site receptor, the concentrations for PM_{10} / $PM_{2.5}$ are at most 23% of the annual mean limit values, only 2% of this is a contribution due to the Drehid WMF.

Table 11.16: Dispersion Model Results – PM_{10}

Pollutant / Scenario	Annual Mean Background ($\mu g/m^3$)	Averaging Period		Process Contribution ($\mu g/m^3$)	Predicted Environmental Concentration ($\mu g/Nm^3$)	Standard ($\mu g/Nm^3$) Note 1
PM_{10} / 2013	n/a	Maximum 24-hr mean (as a 90th%ile) Note 2		1.76	18.7	50
	8.6	Annual mean		0.62	9.2	40
PM_{10} / 2014	n/a	Maximum 24-hr mean (as a 90th%ile) Note 2		1.91	18.7	50
	8.6	Annual mean		0.67	9.3	40
PM_{10} / 2015	n/a	Maximum 24-hr mean (as a 90th%ile) Note 2		2.06	18.8	50
	8.6	Annual mean		0.76	9.4	40
PM_{10} / 2016	n/a	Maximum 24-hr mean (as a 90th%ile) Note 2		1.76	18.7	50
	8.6	Annual mean		0.62	9.2	40
PM_{10} / 2017	n/a	Maximum 24-hr mean (as a 90th%ile) Note 2		1.95	18.7	50
	8.6	Annual mean		0.68	9.3	40

Note 1 Air Quality Standards 2011 (from EU Directive 2008/50/EC)

Table 11.17: Dispersion Model Results – $PM_{2.5}$

Pollutant / Scenario	Annual Mean Background (µg/m³)	Averaging Period	Process Contribution (µg/m³)	Predicted Environmental Concentration (µg/Nm³)	Standard (µg/Nm³)[Note 1]
$PM_{2.5}$ / 2013	3.0	Annual mean	0.6	3.6	25
$PM_{2.5}$ / 2014	3.0	Annual mean	0.7	3.7	25
$PM_{2.5}$ / 2015	3.0	Annual mean	0.8	3.8	25
$PM_{2.5}$ / 2016	3.0	Annual mean	0.6	3.6	25
$PM_{2.5}$ / 2017	3.0	Annual mean	0.7	3.7	25

Note 1 Air Quality Standards 2011 (from EU Directive 2008/50/EC)

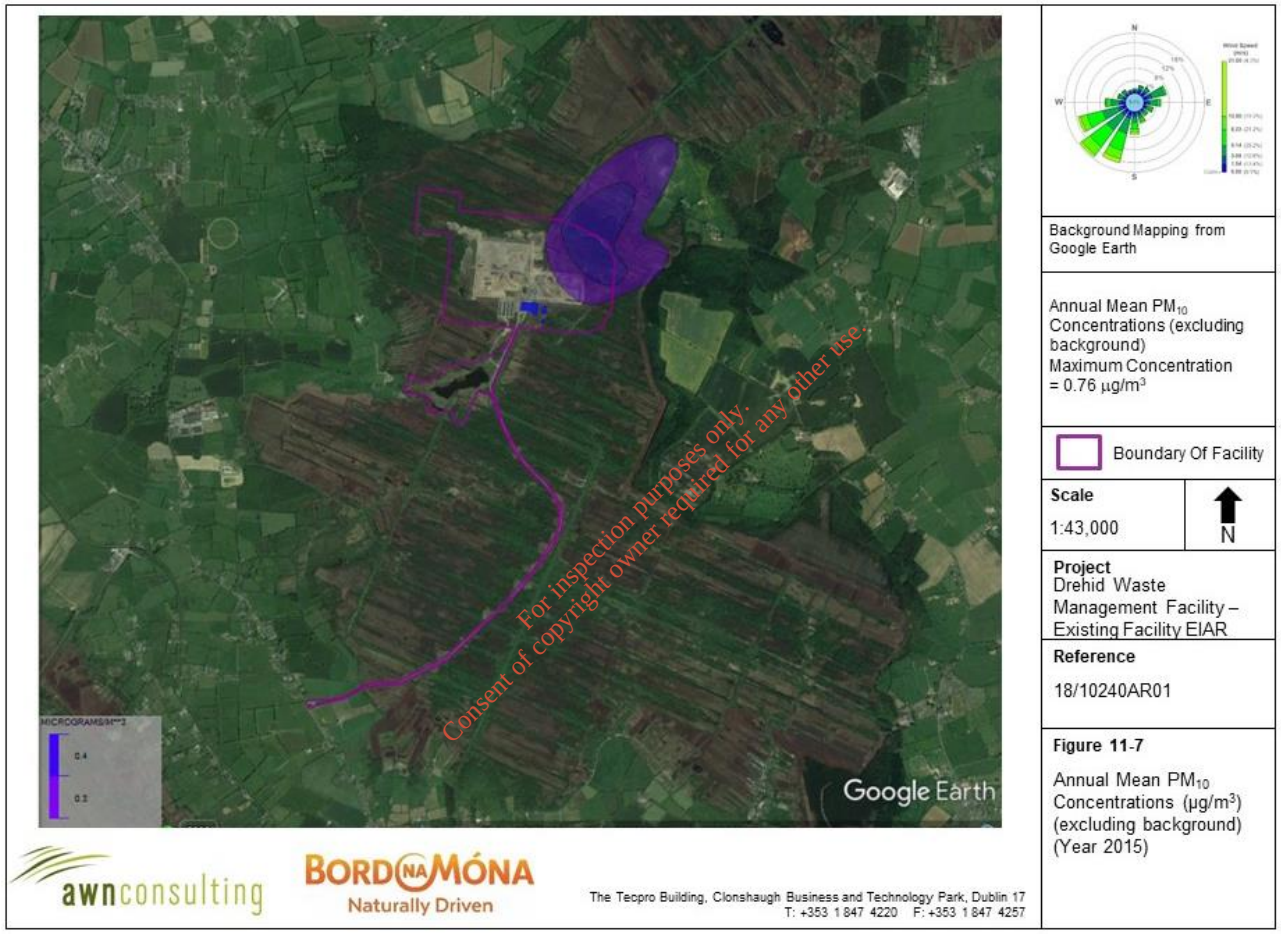


Figure 11.7: Annual Mean PM_{10} Concentrations (µg /m^3) (excluding background) (Year 2015)

11.4.3 Climate Assessment

There is the potential for a number of greenhouse gas emissions to atmosphere during the existing operation of the Drehid Facility. Road traffic and space heating of buildings may give rise to CO_2 and N_2O emissions. However, due to the size of the facility and traffic volumes generated the impact of the existing facility on national greenhouse gas emissions is predicted to be insignificant in terms of Ireland's obligations under the EU 2020 target.

The regional impact of the existing facility on emissions of NO_x and VOCs has been assessed using the procedures of Transport Infrastructure Ireland (TII 2011) and the UK Department for Environment, Food and Rural Affairs (UK DEFRA, 2016). Similar to the air traffic assessment, the impacts due to traffic can be scoped out as imperceptible due to the low number of vehicles associated with the existing facility.

11.4.4 Regional Climate Impacts

Total greenhouse gas from landfilling of untreated MSW will not change due to the existing facility. EU research indicates that MSW greenhouse gas emissions amount to 328 kg CO_2eq/tonne MSW. At Drehid landfill this would equate to 0.09% in terms of Ireland's obligations under the EU 2020 Target (EU 2014). The engineered landfill is currently limited to a maximum of 120,000 TPA.

Therefore, the likely overall magnitude of the changes on climate in the operational stage is imperceptible, national and long-term.

11.4.5 Impact of Climate Change on the Project

The most likely impact due to climate change on the existing facility is due to flooding, an assessment has been carried out in Chapter 7 of this EIAR to ensure that the site has sufficient capacity in the system for adaption to future increased rainfall due to climate change.

Areas of pluvial flooding were noted on the OPW Preliminary Flood Risk Assessment PFRA mapping, but no records of fluvial flooding were noted on the OPW/CFRAM website for the site. Drainage improvement works have rectified the drainage on the site and reduced the potential for surface water ponding.

The network of drainage ditches effectively drain the site and surrounding area. Small areas of pluvial flooding occur to the north-west and west of the site; however improved drainage and water management has limited the potential for flooding in this area.

No incidents of flooding were noted at the site after detailed review of historical maps, data from CFRAMs and PFRA and internet searches were consulted. The existing facility site is not located in a flood prone area (Flood Zone A or B) based on the preliminary flood risk assessment (PFRA) maps.

11.5 MITIGATION MEASURES

11.5.1 Construction Phase

The greatest potential impact on air quality during the construction phase of new landfill capacity is from dust emissions, PM_{10}/$PM_{2.5}$ emissions and the potential for nuisance dust.

In order to minimise dust emissions during construction of new phases, a series of mitigation measures have been prepared in the form of a dust minimisation plan. Provided the dust minimisation measures outlined in the Plan (see Appendix 11.4) and construction management plan are adhered to, the air quality impacts during the construction phase should not be significant.

In summary the measures which will be implemented will include the following;

- Hard surface roads will be swept to remove mud and aggregate materials from their surface while any un-surfaced roads will be restricted to essential site traffic;
- Furthermore, any road that has the potential to give rise to fugitive dust must be regularly watered, as appropriate, during dry and/or windy conditions;
- Vehicles using site roads will have their speed restricted, and this speed restriction must be enforced rigidly. On any un-surfaced site road, this will be 20 kph, and on hard surfaced roads as site management dictates;
- Vehicles delivering material with dust potential (soil, aggregates) will be enclosed or covered with tarpaulin at all times to restrict the escape of dust;
- Public roads outside the site will be regularly inspected for cleanliness, and cleaned as necessary;
- Material handling systems and site stockpiling of materials will be designed and laid out to minimise exposure to wind. Water misting or sprays will be used as required if particularly dusty activities are necessary during dry or windy periods; and
- During movement of materials both on and off-site, trucks will be stringently covered with tarpaulin at all times. Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions.

At all times, these procedures will be strictly monitored and assessed. In the event of dust nuisance occurring outside the site boundary, movements of materials likely to raise dust would be curtailed and satisfactory procedures implemented to rectify the problem before the resumption of construction operations.

11.5.2 Odour

The Drehid facility (W203-01) operates an odour mitigation and management plan which includes a range of practical odour abatement measures for the Composting facility. All processes associated with the Composting Facility are internal within buildings under negative pressure so air does not escape from the buildings.

An odour management plan has been developed for the existing landfill facility. This plan includes management strategies for the prevention of emissions and a strict preventative maintenance and management program for ensuring that all odour mitigation techniques remain operational at optimal capacity throughout all operational scenarios. Good housekeeping practices (internally and externally) and a closed-door management strategy will also be maintained at all times.

If composting temperatures exceed approximately 65°C, odour emissions increase significantly, due to the changes in process biochemistry. Excessive increases in composting temperatures are especially relevant in the first stage of composting when, due to the fast degradation, a lot of energy is released. Temperature sensors are used to measure the temperature in the composting tunnels and subsequently in the maturation area. The SCADA control system ensures that the composting temperature does not exceed 65°C by adding more fresh process air to the composting mass. This reduces the odour load in the process air being transported to the odour abatement systems.

Critical and key odour abatement system performance parameters are continually monitored on the SCADA control system. Should any parameter deviate outside of its accepted range, an alarm will be immediately generated. Critical alarms will be texted to selected mobile phone numbers thereby ensuring the communication of critical alarms to responsible individuals on a 24 hour basis.

The biofilters are maintained to ensure optimum performance. Biofilters are compartmentalised to facilitate maintenance and replacement of media. Each biofilter comprises two sections such that treatment is provided by one of the sections while the other section is being maintained. Biofilters are covered and hence isolated from extreme weather conditions (e.g. intensive rainfall or intensive heat) thereby providing optimum control of biofilter efficacy.

11.5.3 Air Quality

There is no significant predicted operational phase impact with respect to air quality from traffic. However, some site-specific mitigation measures are required for the existing development, in particular the prevention of vehicles from having engines idling while waiting to be processed, even over short time periods.

Mitigation measures in relation to traffic-derived pollutants have focused generally on improvements in both engine technology and fuel quality. EU legislation, based on the EU sponsored Auto-Oil programmes, has imposed stringent emission standards for key pollutants (Regulation (EC) No 715/2007) for passenger cars to be complied with in 2009 (Euro V) and 2014 (Euro VI). With regard to heavy duty vehicles, EU Directive 2005/78/EC defines the emission standard currently in force, Euro IV, as well as the next stage (Euro V) which entered into force in October 2009. In addition, it defines a non-binding standard called Enhanced Environmentally-friendly Vehicle (EEV). In relation to fuel quality, SI No. 407 of 1999 and SI No. 72 of 2000 have introduced significant reductions in both sulphur and benzene content of fuels.

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

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

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

11.6 CUMULATIVE IMPACTS

The only significant developments in the vicinity of the existing Drehid facility which have been granted planning permission is the MBT Facility.

The cumulative impacts of all relevant permitted developments as well as the proposed future development works at the facility were assessed in a Proposed MBT Development EIAR and have not been reproduced here. It was found that should the construction phases of the permitted and proposed developments at the facility and any localised permitted developments coincide, it is predicted that once appropriate mitigations are put in place during the construction for the above schemes, impacts will not be significant. The cumulative impact of the proposed future development works at the Drehid facility and the ongoing operation of the existing Drehid facility are also predicted to not cause significant impacts during the operational phase with respect to local air quality for the long and short term.

11.7 WORST CASE IMPACT

In order to protect nearby sensitive receptors, construction and operational phase impacts have been assumed to be worst case for odour, air and climate emissions throughout the assessment.

Potential construction phase impacts have been taken to be worst case for any occasional construction activities associated with development of additional landfill capacity and therefore strict mitigation measures have been outlined in a dust minimisation plan (Appendix 11.4) and any construction works

associated with the development of additional landfill capacity is carried out in accordance with a Construction Management Plan which is agreed in advance with Bord na Móna. The mitigation measures for dust are designed with a number of layers of protocol, therefore if one fails in the short-term it should be eliminated by the next. Construction dust monitoring occurs as part of the IED Licence (W0201-03) which will be in place to ensure that, should mitigation measures fail and construction dust impacts occur, they will be at worst slight, localised and short term in nature.

The effects in the operational phase is not significant and long term with respect to odour, air quality or climate.

11.8 DIFFICULTIES ENCOUNTERED

There were no difficulties encountered in the assessment of the existing Drehid WMF.

11.9 ASSESSMENT SUMMARY

The scenarios modelled lead to odour concentrations which are in compliance with the relevant odour criterion of 3.0 OU_E/m^3 measured as a 98th%ile of mean hourly odour concentrations at the worst case receptor.

The maximum 1-hour 98th%ile odour concentration at the worst case sensitive receptors is 2.43 OU_E/m^3. This is equivalent to 81% of the relevant odour criterion of 3.0 OU_E/m^3 measured as a 98th%ile of mean hourly odour concentrations at the worst case receptor. This can be classed as an imperceptible, long term, reversible and localised impact at the worst case receptor.

With regard to NO_2, the modelled scenario will lead to ambient NO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 21.4% of the 1-hour limit value (measured as a 99.8th%ile) and 32.4% of the annual limit value at the worst-case off-site location. This can be classed as an imperceptible, long term, reversible and localised impact at the worst case receptor.

With regard to PM_{10} / $PM_{2.5}$, emissions from the facility will lead to ambient PM_{10} / $PM_{2.5}$ levels (including background) which are in compliance with the relevant limit values, with levels reaching at most 39% of the relevant limit values at the worst-case off site location. This can be classed as an imperceptible, long term, reversible and localised impact at the worst case receptor.

It has been assumed that all emission points are continually in operation for the full year as a worst-case assumption.

In summary all emissions from the activities related to the existing Drehid WMF will be in compliance with the ambient air quality standards and will lead to a direct, not significant and long-term impact of non-compliance or odour nuisance. There is a direct, local, not significant and long-term impact predicted due to vehicles emissions during the operational phase.

12 NOISE AND VIBRATION

12.1 INTRODUCTION

This section of the EIAR assesses the noise and vibration impacts associated with the existing licensed waste management activities at the Drehid WMF site, Timahoe, Co. Kildare. Chapter 3 (Description of the Existing Environment, Ongoing and Future Activities) provides the detail of the description of the existing licensed facility and the permitted operations.

This chapter was completed by Jennifer Harmon. She is a Senior Acoustic Consultant with AWN Consulting. She holds a BSc (Hons) in Environmental Science from the University of Ulster and a Diploma in Acoustics and Noise Control from the Institute of Acoustics of which she is a full Member.

When considering the key noise impacts associated with the existing facility, consideration has been given to the existing permitted operations which include the landfill and composting facility.

12.2 ASSESSMENT METHODOLOGY

The assessment has been undertaken with reference to the most appropriate guidance documents relating to environmental noise and vibration which are set out within the relevant sections of this chapter and included in the references section. In addition to specific noise guidance documents, the following guidelines were considered and reviewed for the preparation of this chapter:

- Guidelines on the Information to be contained in Environmental Impact Statements', (EPA, 2002);
- 'EPA Advice Notes on Current Practice (in the preparation of Environmental Impact Statements), (EPA, 2003);
- 'Guidelines on the Information to be contained in Environmental Impact Assessment Reports', (Draft August 2017); and
  'EPA Advice Notes for Preparing Environmental Impact Statements, (Draft, September 2015).

The study has been undertaken using the following methodology:

- A review of the baseline noise survey undertaken as part of the Proposed Development EIAR has been undertaken to determine the existing noise climate associated with the current site activity;
- A review of annual noise monitoring surveys conducted as part of the existing licensed WMF has been undertaken to supplement the baseline surveys in order to characterise the baseline noise levels;
- Predictive calculations have been performed to assess the noise levels associated with current and future operational sources associated with the ongoing operation of the WMF at the most sensitive locations surrounding the development site, and;
- A schedule of mitigation measures has been proposed to reduce, where necessary, the identified potential impacts relating to noise and vibration from the facility.

12.3 RECEIVING ENVIRONMENT

The overall Bord na Móna landholding is located within the Timahoe bog in Allenwood, County Kildare. Within the landholding, Bord na Móna operates the permitted Drehid WMF, accessed from the regional R403 road, at Killinagh Upper, by a 4.8 km long internal access road, which is dedicated to the existing facility.

The Drehid WMF is licensed by the EPA (IED Licence number W0201-03). This existing facility compromises an engineered landfill, composting facility and associated infrastructure including administration buildings, gas utilisation plant, settlement lagoons, leachate management infrastructure, weighbridge and access roads. The hours of operation of the existing facility are limited to operation between the hours of 08:00 and 19:00 Monday to Saturday. The waste acceptance hours are between 08:00 and 18:30 Monday to Saturday.

In terms of noise generating activities, the main sources within the existing facility relate to vehicles entering and existing the site, mobile plant and equipment working at landfill areas and accessing the composting facility, operational plant serving the composting facility and a gas utilisation plant. All activities cease on site post 19:00 with the exception of the compost facility fans (housed internally) and the gas utilisation plant, both of which operate continuously.

The surrounding environment is rural in nature with residential properties located around all boundaries at varying distances from the landholding boundary. The red line boundary of the Drehid WMF is positioned within the central part of the landholding and, hence, is significantly set back from noise sensitive properties. The closest properties are at distances of approximately 970 m to the northeast of the landfill and 1,280 m to the south-west of the composting plant.

12.3.1 Annual Noise Monitoring

In accordance with the conditions of the existing licence (W0201-03), a scheduled noise survey is undertaken on an annual basis over a day and night-time period at the nearest sensitive receptor (N1) and at the boundary locations within the site (N2 to N5). The most recent survey results for the years 2015, 2016 and 2017 are summarised in this Section.

12.3.1.1 Monitoring Locations

Noise monitoring is undertaken at five locations. One of these locations is a noise sensitive property whilst the remainder four locations are at boundary locations around the perimeter of the site. These are described below and displayed in the environmental monitoring locations Figure 3.4 of the EIAR. Figure 12.1 presents the noise monitoring locations in isolation.

N1 Noise Sensitive receptor located to the south-west of the WMF footprint.

N2 Boundary location to the north west of the facility on the L5025 road.

N3 Boundary location to the north east of the facility.

N4 Boundary location to the south west of the WMF along the R403 road at the entrance to the facility.

N5 Boundary location to the south east of the facility.

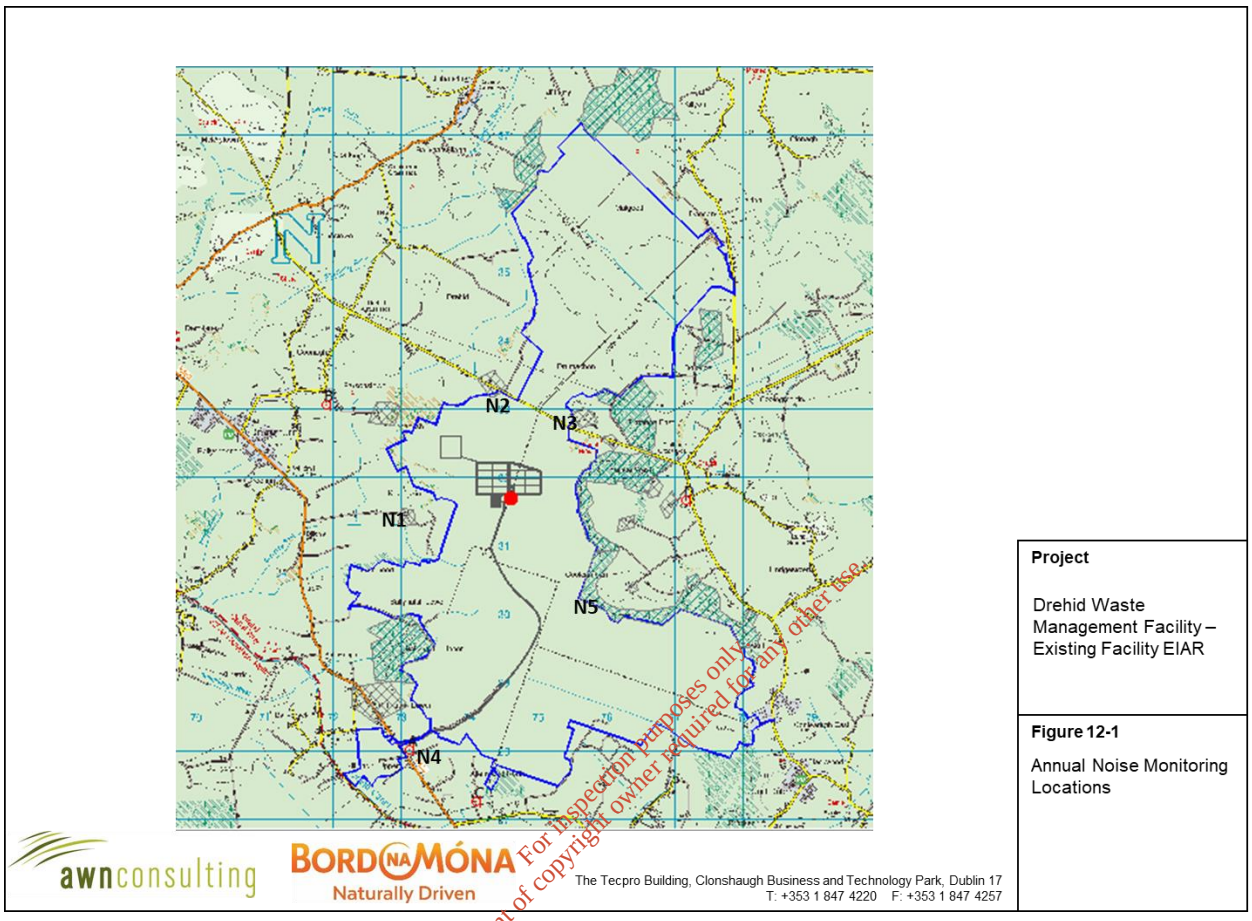


Figure 12.1: Annual Noise Monitoring Locations

12.3.1.2 Monitoring Procedure and Periods

2015: The daytime surveys were conducted on 19 and 20 October 2015.

The night-time surveys were conducted on 20 October and 11 November 2015.

2016: The daytime surveys were conducted on 19 and 20 October 2016.

The night-time surveys were conducted on 20 October 2016.

2017: The daytime surveys were conducted on 5 and 12 October 2017.

The night-time surveys were conducted on 8 and 9 November 2017.

The surveys were undertaken in general accordance with *ISO 1996-2:2007 Acoustics -- Description, measurement and assessment of environmental noise - Part 2: Determination of environmental noise*

levels (2007) and in accordance with the EPA's noise survey and assessment guidance document *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities* (Original Version 2012, updated Guidance 2016). The surveys were undertaken during dry and calm conditions with wind speeds less than <3 m/s.

12.3.1.3 Monitoring Parameters

The noise survey results are presented in terms of the following four parameters:

L_{Aeq} is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period.

L_{Amax} is the instantaneous maximum sound level measured during the sample period.

L_{A90} is the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.

L_{A10} is the sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for traffic noise.

12.3.1.4 Monitoring Results

The monitoring results for day and night-time periods surveyed in 2015, 2016 & 2017, for the five survey locations are summarised in Table 12.1, Table 12.2 and Table 12.3.

Table 12.1: Drehid Facility, 2015 Annual Noise Survey Results

Monitoring Location	Time Period	L_{Aeq}	L_{A10}	L_{A90}	L_{AFMax}	Notes
N1 (NSL)	Day	35 - 37	36 - 39	25 - 31	54 - 63	Faint mobile plant. Distant traffic, birdsong & barking dogs
	Night	30 - 31	31 - 33	26 - 28	53 - 54	Distant traffic. Occasional barking dogs.
N2	Day	47 - 54	46 - 55	24 - 35	66 - 72	Machinery faintly audible. Birdsong, passing road traffic
	Night	27 - 50	30 - 52	25 - 34	56 - 71	Faint plant noise. Road traffic dominates
N3	Day	38 - 46	41 - 49	29 - 33	53 - 65	Landfill mobile plant, traffic on local road
	Night	33 - 52	32 - 52	26 - 41	55 - 70	Idling van and traffic dominate. Operational plant, low level hum. Idling
N4	Day	64 - 68	65 - 68	37 - 42	87 - 93	Vehicles on site entrance road, traffic along R403 Road
	Night	46 - 53	43 - 59	25 - 32	72 - 70	Passing traffic along R403
N5	Day	38 - 36	38 - 42	27 - 28	61 - 63	Vehicles along site road, surrounding road traffic. Birdsong

Monitoring Location	Time Period	L_{Aeq}	L_{A10}	L_{A90}	L_{AFMax}	Notes
	Night	30 - 32	29	22 - 23	63 - 68	Faint plant noise. Bird and animal noises

The monitoring results for day and night-time periods surveyed in 2016 for the five survey locations are summarised in Table 12.2.

Table 12.2: Drehid Facility, 2016 Annual Noise Survey Results

Monitoring Location	Time period	L_{Aeq}	L_{A10}	L_{A90}	L_{AFMax}	Notes
N1 (NSL)	Day	35 - 43	35 - 46	28 - 38	58 - 68	Faint mobile plant & reverse alarms. Distant traffic, birdsong & barking dogs
	Night	33 - 34	36 - 37	27 - 30	60 – 61	Distant traffic. Occasional barking dogs. Faint plant audible
N2	Day	51 - 56	49 - 59	30 - 33	74 - 77	Machinery faintly audible. Birdsong, passing road traffic
	Night	27 - 45	24 - 31	19 - 20	60 – 63	Faint plant noise. Road traffic dominates, livestock & dogs barking (round 2)
N3	Day	41 - 49	45 - 52	25 - 31	62 – 70	Traffic on local road dominates. Landfill mobile plant & reverse alarms, low level plant,
	Night	24 - 45	22 - 36	18 - 20	52 – 84	Faint operational plant. Occasional traffic on L5025 (Round 2)
N4	Day	64	65 - 66	40 - 47	85	Vehicles on site entrance road, traffic along R403 Road
	Night	38 - 49	32 - 50	23 - 27	71 – 77	Passing traffic along R403
N5	Day	35 - 39	35 - 41	29 - 33	63 – 67	Vehicles along site road, mobile plant and fans. Surrounding road traffic & birdsong
	Night	34 - 38	31 - 32	24	71 - 89	Faint plant noise. Bird and animal noises

Table 12.3: Drehid Facility, 2017 Annual Noise Survey Results

Monitoring Location	Time period	L_{Aeq}	L_{A10}	L_{A90}	L_{AFMax}	Notes
N1 (NSL)	Day	38 – 42	41 – 44	34 – 36	62 – 72	Faint reverse alarms and faint mobile plant. Distant traffic, Plant from adjacent facility, activities from nearby dwellings
	Night	33 – 35	34 – 38	29 – 32	54 – 63	Distant traffic. Plant from adjacent facility

N2	Day	52 – 56	55 – 60	42 – 48	73 - 78	Passing road traffic dominates. Machinery faintly audible from site. Birdsong.
	Night	36 – 41	36 – 41	24 – 26	41 – 74	Road traffic dominates, livestock & plant from adjacent facility
N3	Day	49 – 53	51 – 56	41 – 45	70 – 72	Traffic on local road dominates. Landfill mobile plant & reverse alarms faintly audible
	Night	33 – 56	30 – 53	23 – 26	33 – 77	Occasional traffic on L5025. Plant at low level from adjacent facility
N4	Day	59 – 62	60 – 65	42 – 46	72 – 81	Vehicles on site entrance road, traffic along R403 Road
	Night	41 – 50	45 – 50	28 – 30	71 – 74	Passing traffic along R403
N5	Day	43 – 48	44 – 46	36 – 37	70 – 74	Vehicles along site road, mobile plant & plant. Surrounding road traffic & birdsong & barking dogs
	Night	29	29	25	60 - 61	Bird and animal noises. Faint plant from adjacent facility

The annual monitoring reports note that activities from the Drehid WMF are audible at very low levels in the absence of other surrounding sources such as road traffic. The two sources noted to be faintly audible during the survey periods were occasional mobile plant activity in addition to operational plant. The ambient noise level measured by the L_{Aeq} parameter, at the monitoring locations set back from road traffic, was well below the daytime and night-time noise emission limit values of 55 and 45 dB $L_{Aeq,\ 30mins}$ respectively. The steady state background noise level measured by the L_{A90} parameter is low at all monitoring locations indicating the low contribution of the operational facility to the overall noise environment.

12.3.2 Additional Noise Monitoring Survey

A separate noise monitoring survey was undertaken by AWN Consulting in order to further inform this assessment. Survey details are set out below.

12.3.2.1 Monitoring Locations

Monitoring was undertaken at four locations, representative of the closest noise sensitive boundaries of the existing facility where noise sensitive properties are located. These are described as follows and illustrated in Figure 12.2.

Location A South of facility along R403 Road at entrance to soccer pitch grounds. Location representative of properties along this road in proximity to the site entrance. This location is in proximity to Annual survey location N4.

Location B Noise Sensitive receptor located to the north-west of the existing and proposed facility.

Location C South of existing and proposed facility along small local road within North Allenwood.

Location D East of existing and proposed facility off the L1019 local road in proximity to school and public house.

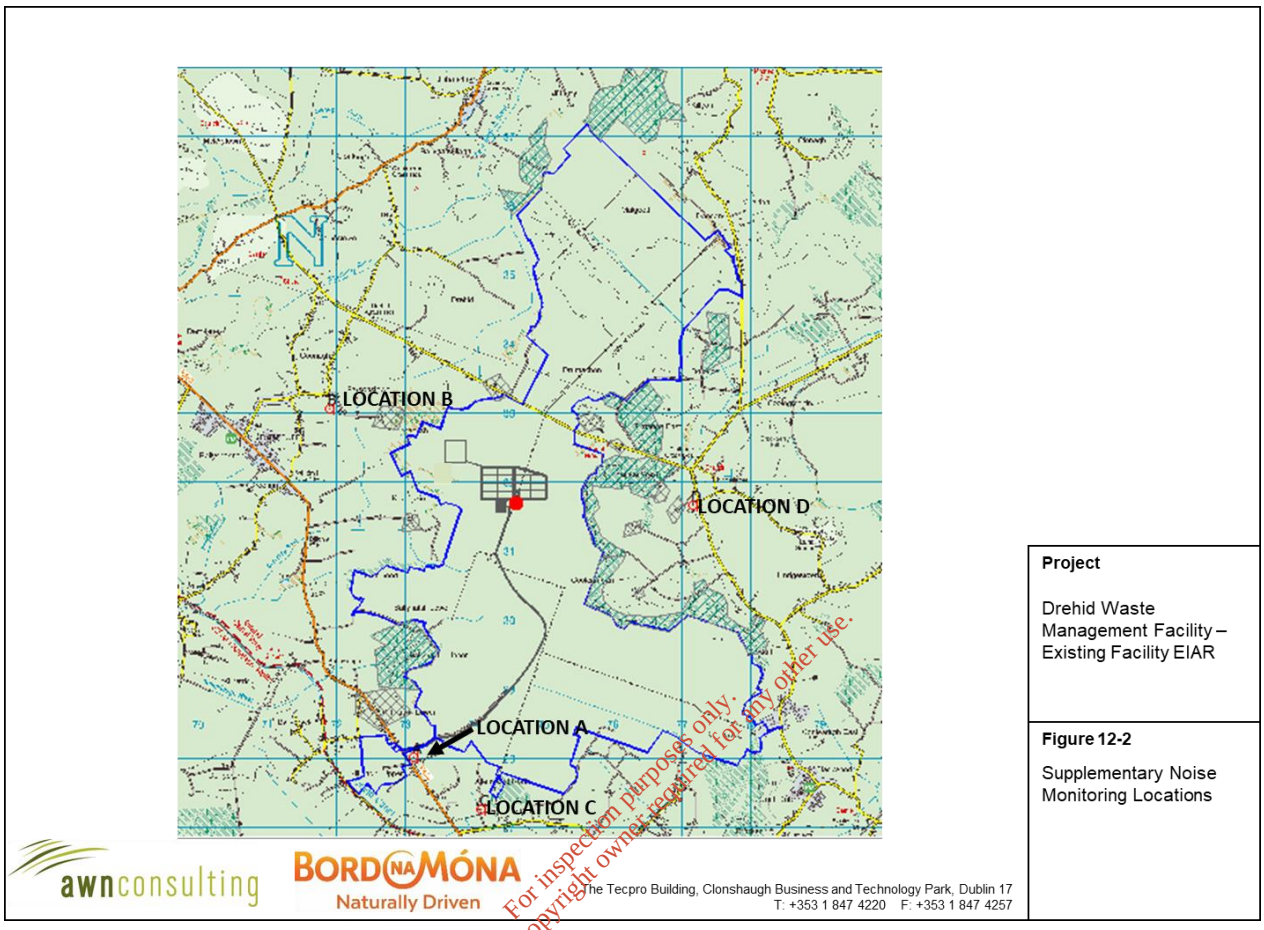


Figure 12.2: Supplementary Noise Monitoring Locations

12.3.2.2 Monitoring Periods and Weather

The daytime surveys undertaken by AWN Consulting were conducted on 11 and 12 July 2016. The night-time surveys were conducted on 18 January 2017. All survey periods were 30 minutes in duration with the exception of the second round of night-time surveys which were 15 minutes in duration. The surveys were undertaken during dry and very calm conditions with wind speeds less than <1 m/s. The same monitoring parameters were recorded as described in Section 12.3.1.3

12.3.2.3 Monitoring Results

The monitoring results for day and night-time periods for the four survey locations are summarised in Table 12.4.

Table 12.4: Baseline Noise Monitoring 2016/2017

Monitoring Location	Time period	Date /Time	L_{Aeq}	L_{A10}	L_{A90}	L_{AFMax}	Notes
A	Day	12:30	69	72	37	89	Road traffic along R403 Road and vehicles along site entrance road.
		16:12	70	74	42	89	
		11:53	70	72	39	90	
	Night	23:04	54	46	20	79	Occasional passing traffic along R403. No other significant noise sources, very quiet background noise.
		02:06	47	46	19	68	1 car passing. Distant traffic.
B	Day	13:13	43	45	37	66	Birdsong, leaf rustle, faint plant audible, flowing stream. Livestock noise within nearby field. Tractor within adjacent field
		16:53	40	41	35	62	As above
		12:17	44	43	33	66	As above, No tractor in adjacent field.
	Night	23:47	49	28	20	78	2 vehicles passing along local road. No other significant sources noted.
		02:27	39	32	21	57	No traffic passing monitoring location. Distant traffic.
C	Day	15:33	46	45	37	75	Birdsong, occasional passing traffic, traffic from R403 and Adjacent roads.
		11:17	45	41	33	72	As above, noise from community centre workshops. Children playing outside community centre.
		13:29	46	38	31	74	As above.
	Night	01:18	32	30	27	54	Occasional traffic on R403
		02:51	31	28	25	56	Distant traffic
D	Day	14:50	47	48	37	75	Birdsong, leaf rustle, 1 car passing along L1019
		10:30	39	40	32	64	As above, aircraft overhead. Plant noise faintly audible in background
		12:51	49	40	32	75	As above.
	Night	00:35	36	31	19	59	Very occasional traffic movements
		03:14	28	28	19	50	No passing traffic. No significant sources noted. Very faint distant traffic.

During daytime survey periods, measured noise levels were dominated by road traffic and environmental sources including livestock, birdsong and leaf rustle. During very calm and quiet periods, activity from the

existing Drehid facility was audible at low level including mobile plant on site and plant noise. The ambient noise levels were typically in the range of 40 to 49 dB L_{Aeq} with higher noise levels recorded at Location A which was dominated by passing road traffic. The background noise levels recorded during the daytime period were typically in the range of 31 to 37 dB L_{A90} with higher values (up to 42 dB L_{A90}) recorded at Location A.

During the night-time period, noise levels were dominated by passing and distant traffic. Very calm conditions prevailed and hence in absence of leaf rustle or other wind generated noise, background noise levels were low. Operational plant within the existing Drehid facility was not audible.

12.3.2.4 Summary of Baseline Noise Environment

The baseline noise environment in the vicinity of the existing facility is low and typical of a rural setting. The operation of the WMF contributes to occasional audible noise levels external to the site at the nearest noise sensitive locations, predominately from on-site mobile plant items and background plant noise. The main sources of noise in the surrounding environment is from local road traffic. In the absence of the existing WMF, the baseline noise environment would remain similar to that recorded during baseline surveys.

12.4 CHARACTERISTICS OF EXISTING FACILITY

Since December 2017, waste for landfill disposal at the facility has been limited to a maximum of 120,000 TPA. Prior to this since 2008, the landfill was permitted to accept 360,000 TPA of municipal solid waste. The composting facility is permitted to accept 25,000 TPA.

When complete, the engineered landfill will consist of 15 No. fully lined phases. Currently Phases 1 to 4 are completed. Initial landfilling has been completed in Phases 5 to 11 and waste is being given time to self-compact with temporary capping in place. The remaining Phases 12 to 15 will be completed up until 2028. Waste filling is ongoing within Phase 12, Construction of Phase 13 has recently been completed and undercell drainage works for Phase 14 have been carried out. The future development of further capacity is detailed in Chapter 3.

Ongoing and Future Activities:

- Landfilling of waste will continue at a maximum rate of 120,000 TPA up to 2028;
- Waste material will continue to be placed in Phases 5 – 12 up to the maximum permitted height (allowing for capping and settlement);
- Placement of waste is anticipated to commence in Phase 13 in Q4 2018 subject to incoming waste quantities;
- Final capping works will continue as phases cease waste deposition;
- Construction of Phase 14 is anticipated to commence in Q2 2020;
- Construction of Phase 15 is anticipated to commence in 2022; and;

- Composting facility will continue to operate on a daily basis within permitted 25,000 TPA limit.

The key sources of noise associated with existing and future on-site activities include the following:

- Traffic entering and exiting the site;
- Mobile plant working at landfill areas during its ongoing construction, operation and capping; and
- Operational plant and equipment associated with compost building.

There are no notable vibration impacts sources associated with the operational phase.

12.5 POTENTIAL IMPACTS OF THE EXISTING FACILITY

12.5.1 Assessment Criteria

The existing WMF activities are licensed by the EPA in Licence (W0201-03). The licence includes operational noise emission limit values (ELV) which are specified under Schedule B Emission Limits. Schedule B.3 includes the relevant noise emission limits, reproduced below.

Table 12.5: Operational Noise ELV's from Waste Licence (W0201-03)

Daytime dB(A) $L_{Aeq, (30minutes)}$	Night-time dB(A) $L_{Aeq, (30minutes)}$
55 Note 1	45 Note 1

Note 1: There shall be no clearly audible tonal component or impulsive component in the noise emission from the activity at any noise sensitive location.

The time periods for day and night-time within the current licence are as follows:

- Daytime: 08:00 to 22:00
- Night-time: 22:00 to 08:00

Vibration

There are no operational vibration limits set within the existing licence. There are no sources of vibration associated with the existing operations, given the type of activity associated with the facility and the distances to the nearest sensitive buildings. In this instance, operational vibration limits are not deemed necessary.

12.5.2 Construction Phase Impacts

There are no specific construction phase impacts associated with the existing facility. Due to the nature of landfilling operations, construction of new cells is included as part of the ongoing site activities and hence is assessed cumulatively within the operational phase section.

12.5.3 Operational Phase Impacts

12.5.3.1 On-site Noise Sources

Noise sources associated with the existing facility are associated with traffic entering and exiting the site, mobile plant working at landfill areas, mobile plant accessing composing buildings and external operational plant and equipment associated with the compost building.

In order to determine the specific noise levels associated with the existing facility, a 3D noise model of the existing facility was developed, using the following information:

- OS mapping of surrounding environment;
- Layout of approved landfill areas,
- Operational plant and equipment types;
- 3D ground contour data; and
- Traffic flow data entering and exiting the site.

The model developed using a proprietary noise calculation package Brüel & Kjær Type Predictor. This is an acoustic modelling package for computing noise levels in the vicinity of different types of noise sources. The calculation standard used in the model for fixed plant and industrial type sources is ISO *9613-2:1996 Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation*. For road traffic noise, the model calculates noise levels in accordance with the UK's *Calculation of Road Traffic Noise* (CRTN - 1988) standard.

The model takes account of the various factors affecting the propagation of sound in accordance with the standard, including:

- the magnitude of the noise source in terms of sound power;
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- attenuation due to atmospheric absorption, and;
- meteorological effects such as wind gradient, temperature gradient and humidity

<u>Landfill Operations</u>

The landfill will operate until 2028 over a total of 15 No. Phases as described in Section 12.4 and in further detailed in Chapter 3.

The key sources of noise from this area of the site are from delivery vehicles and mobile plant used for clearance, waste deposition and capping. These will essentially be the use of excavators, dump trucks and dozers. For the purpose of this assessment, the use of 1 No. excavator, 1 No. dump truck, 1 No.

dozer and 1 No. compactor has been modelled to operate for 66% of the operating day within the eastern and western boundaries of the landfill site to determine a worst-case scenario for the closest noise sensitive locations to each boundary.

Source data has been taken from BS 5228-1:2009+A1:2014 for the modelled items of plant as summarised. All source data is modelled using an A-weighted octave band spectrum.

Table 12.6: Source Noise Levels Used for Landfill Operations

Plant Item	BS 5228 Ref	dB L_{Aeq} at 10 m
Dozer	C2.10	80
Dump Truck (Tipping Fill)	C2.30	79
Tracked Excavator	C2.14	79
Wheeled Compactor	C8.1	80

Landfill Cell Construction

As part of ongoing operations at the facility, the development (construction) of new cells is planned to occur within Phase 14 and Phase 15 in 2020 and 2022, respectively, with an estimated construction duration of 6 months each. Additional mobile plant will be required during these phases to excavate and construct the cells. Table 12.7 summarises the additional machinery on site used for this phase.

Table 12.7: Source Noise Levels Used for Landfill Cell Construction

Plant Item	BS 5228 Ref	dB L_{Aeq} at 10 m
Dozer x 2	C2.10	80
Dump Truck (Tipping Fill) x 2	C2.30	79
Tracked Excavator x 2	C2.14	79
Wheeled Loader x1	C2.27	80
Hydraulic Vibratory Compactor	C2.42	78

Composting Facility

The key sources of noise associated with the composting facility include vehicles delivering material into the composting building for storage and treatment. Internal activities include shredding, screening and sifting of materials. All operational plant and equipment is fully housed within the building. The operational hours of this area are between 07:30 and 19:00 with the exception of the compost fans (enclosed) which will run on a continual basis. In order to model the noise sources from this area, the following assumptions were used, as provided by BnM.

Table 12.8: Source Noise Levels Used for Composting Facility

Plant Item	Number	Location	dB L_{Aeq} at 10 m (each item)
Shredder	1	Internal	85
Overband magnet	1		65
Starscreen	1		75
Windsifter	1		75
Flip flow screen	1		75
Conveyors	10		86
12 no. 30kW fans	12		86
1 no. 11kWfan	1		75
1 no. 90kW fan	1		65

A sound insulation value of 24dB R_w has been used for the building representing a typical light industrial panel system.

Gas Utilisation Plant

A gas utilisation plant is located to the south of the existing landfill. The key source of noise generation within the compound are the four enclosed gas engines and one exhaust stack. The gas engines and stack typically run on a continual basis (24/7). Source data for this equipment supplied by BnM is summarised in Table 12.9.

Table 12.9: Source Noise Levels Used for Gas Utilisation Plant

Plant Item	Source Noise Level at 1m	No. of Items	Height (m)
Gas Engine	82	4	3
Centrifugal Blower (gas booster)	79	2	2

On-site vehicle Movements

In addition to the fixed working areas noted in the sections above, the noise model has also accounted for on-site vehicle movements along the haul road, leading from the R403 to landfill and composting areas.

In order to account for a worst-case assessment, traffic volumes associated with traffic counts undertaken during the year 2016 have been used within the model. This is highly conservative as it relates to the period when the facility was accepting 360,000 TPA of waste to landfill, compared to the reduced permitted capacity in place since December 2018, i.e. 120,000 TPA. The total traffic volumes entering and leaving the site is determined to be 244 HGV's and 54 LGV's movements per day (based on 2016 traffic movements).

During periods when the landfill phases are being constructed, the expected additional traffic entering and existing the site is determined to be a total of 16 HGV's and 54 LGV's movements.

The facility operating hours are licensed between 08:00 to 19:00hrs with waste acceptance permitted between 08:00 and 18:30hrs.. A "moving source" has been modelled along the internal roads within the facility and the landfill areas using a noise source data for an articulated dump truck of 81 dB at 10 m in line with BS5228 Source C.2.33 and a vehicle drive by for a LGV of 62 dB at 10 m.

Modelled Results

Noise levels have been modelled at a total of 17 No. locations surrounding the site, representing the closest noise sensitive locations to the existing facility. These locations are illustrated in Figure 12.3. Table 12.9 presents the calculated noise levels at each of the assessment locations taking account of the operational noise sources and assumptions outlined above.

Results are calculated for the daytime (08:00 to 22:00), and night-time period (22:00 to 08:00). The sources included in the model are operating continually (with exception of landfill items of mobile plant which are modelled as 66% over the full working day). For any given time period, therefore the calculated LAeq will be the same. The results are presented here for a 30minute LAeq to compare against the facilities EPA IED Licence noise limits.

The calculated noise level at the closest noise sensitive locations to the site include all of the sources described in Section 12.5.3.1 in operation simultaneously.

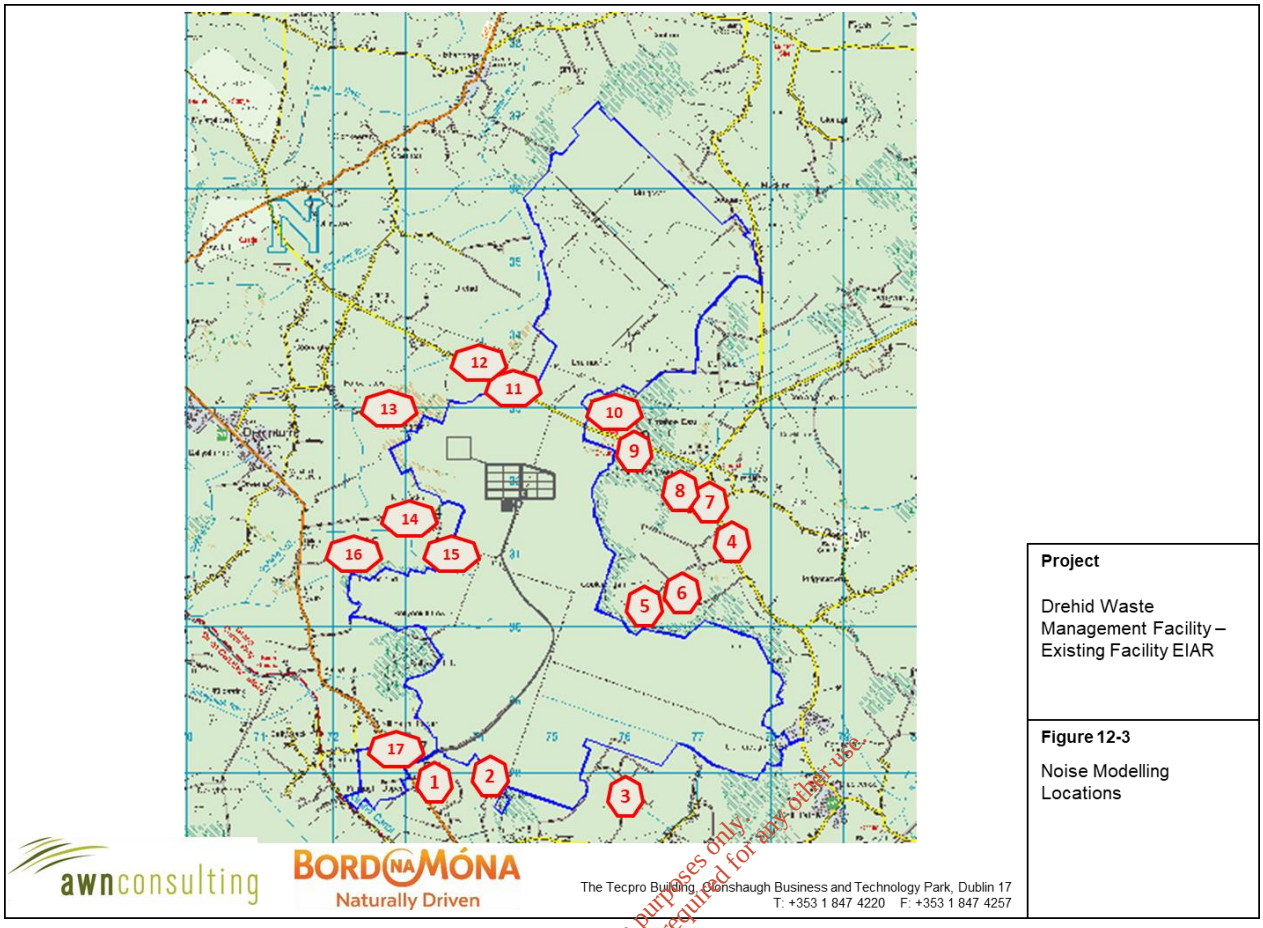


Figure 12.3: Noise Modelling Locations

Table 12.10 below presents the calculated noise levels associated with normal on-site operations associated with landfilling operations and the compost facility.

Table 12.10: Operational Noise Levels – Normal Site Operation

Modelled Location Ref	Description	Calculated Noise Level, dB $L_{Aeq,30mins}$	
		Daytime	Night-time
R1	South. Off R403 Road (Killinagh Upper)	43	--
R2	South – Allenwood North	38	--
R3	Southeast - Allenwood	26	--
R4	East along L1019	18	--
R5	East - Coolcarrigan	33	15
R6		31	14
R7	Northeast – Timahoe west	31	15
R8		30	14
R9	Northeast – Timahoe east	36	19

Modelled Location Ref	Description	Calculated Noise Level, dB $L_{Aeq,30mins}$	
		Daytime	Night-time
R10		37	19
R11	Northwest Drumachon	37	19
R12		34	18
R13	Northwest - Loughnacush	31	15
R14	West - Killkeaskin	36	20
R15		37	17
R16	West - Drummond	27	14
R17	South – off R403 (Killinagh Lwr)	44	--

Note: " - -" Indicates that the contribution of on-site sources at these locations is below model calculation range. These are all below a level of 1 dB(A)

Daytime Periods

During the daytime periods, calculated noise levels are between 18 and 44 dB L_{Aeq}. Highest noise levels are calculated at modelled locations R1 and R17, located off the R403 road and are dominated by traffic along the internal haul road. The next highest modelled noise levels are at locations R2 and R9 to R15 located to the north-east, north and north-west of the facility which are dominated by landfill operations in addition to an element of traffic along the internal haul road. At the remaining locations, noise levels are in the range of 18 to 30 dB L_{Aeq} and are influenced by mobile plant at the landfill areas and lorry movements along the internal haul road. Due to the extensive distances between the nearest noise sensitive locations and the site activities, the overall contribution of the operational site is low and below the daytime noise limit value of 55 dB L_{Aeq}. This is in line with observations made during noise surveys undertaken as part of annual compliance and additional supplemental surveys.

Night-time Periods

During the night-time period, the only operational sources are fans within the compost facility and the gas utilisation plant. Noise levels are calculated between <10 to 20 dB LAeq. The contribution of noise levels from the existing facility during night-periods are all below the night-time noise limit value of 45 dB LAeq. This is in line with observations made during noise surveys undertaken as part of annual compliance and additional supplemental surveys.

Table 12.11 below presents the calculated noise levels associated with normal on-site operations associated with landfilling operations and the compost facility in addition to the construction of landfill cells which are planned to occur for a period of approximately 6 months in 2020 for Phase 14 and 2022 for Phase 15. The results are presented for the daytime period only as night-time operations and calculated results in Table 12.6 will remain unchanged during this scenario.

Table 12.11: Operational Noise Levels - Landfilling with Cell Construction

Modelled Location Ref	Description	Calculated Noise Level, dB $L_{Aeq,30mins}$
		Daytime
R1	South. Off R403 Road (Killinagh Upper)	44
R2	South – Allenwood North	39
R3	Southeast - Allenwood	27
R4	East along L1019	19
R5	East - Coolcarrigan	35
R6		35
R7	Northeast – Timahoe west	35
R8		34
R9	Northeast – Timahoe east	40
R10		41
R11	Northwest Drumachon	40
R12		38
R13	Northwest - Loughnacush	35
R14	West - Killkeaskin	39
R15		39
R16	West - Drummond	29
R17	South – off R403 (Killinagh Lwr)	45

During the calculated scenario which includes for landfill cell construction, calculated noise levels are between 19 and 45 dB L_{Aeq}. The same locations are dominated by traffic along the internal haul road or from activities within the landfill area. As noted above, due to the extensive distances between the nearest noise sensitive locations and the site activities, the overall contribution of the operational site is low and below the daytime noise limit value of 55 dB L_{Aeq}.

12.5.3.2 Traffic Along Surrounding Roads

Traffic travelling to and from the facility are distributed along the surrounding road network once it exits the site. Highest traffic flows associated with the facility are along the R403 road as all traffic entering and existing the facility travels along this road prior to distribution along the surrounding road network.

Traffic count surveys undertaken during 2016 as part of the Proposed Development EIAR indicates that an annual average daily traffic (AADT) flow of 5169 No. vehicles was along the R403 road. The contribution of traffic from the Drehid WMF was determined to be 298 No. vehicles (244 No. HGV's and 54 No. LGV's) during this period. This volume of traffic related to the 360,000 TPA of permitted waste acceptance at the facility until December 2017. The noise contribution of traffic associated with the Drehid facility is negligible compared to that along the road (i.e. less than 1dB(A).)

Since December 2018, permitted waste acceptance at the WMF has reduced to 120,000 TPA which results in a net reduction in traffic entering and exiting the facility. Noise levels associated with traffic along the surrounding road network has therefore been further reduced compared to the 2016 traffic volumes. Further details relating to traffic volumes associated with the existing facility are discussed in Chapter 10 (Material Assets (Roads & Traffic)).

Table 12.12: Subjective Impacts Associated with Changes in Traffic Noise Levels

Change in Sound Level (dB L_{A10})	Subjective Reaction	Magnitude of Impact
0	Inaudible	No Impact
0.1 – 2.9	Barely Perceptible	Negligible
3 – 4.9	Perceptible	Minor
5 – 9.9	Up to a doubling of loudness	Moderate
10+	Doubling of loudness and above	Major

12.6 MITIGATION MEASURES

The layout and design of the site incorporates inherent noise mitigation measures through the position of the landfill and composting activities away from noise sensitive boundaries, the location of operational sources on-site and the hours of operation. The results of noise monitoring compliance surveys and specific noise calculations have indicated that operational noise levels associated with on-site noise sources are all below the facilities noise ELV's for day and night-time periods as set within the current EPA IED Licence.

In order to ensure noise levels associated with the operational phase continue to remain well below the noise ELV's, the following best practice measures are incorporated into the site design as best practice:

- The best means practicable, including proper maintenance of plant, are employed to minimise the noise produced by on site operations;
- Compressors are attenuated models fitted with properly lined and sealed acoustic covers which are kept closed whenever the machines are in use;
- Machinery that is used intermittently is shut down or throttled back to a minimum during periods when not in use;
- All roller shutter doors and building access points are maintained closed at all times and opened only to permit vehicle and personnel entrance/egress;
- All operational plant is switched off during night-time periods when the facility is not in operation, with the exception of the compost building fans and the gas utilisation plant; and
- Where necessary, contractors will be required to erect suitable noise barriers, localised screens or other suitable control measures to minimise noise disturbance in the event that maintenance or other scheduled activities are operated between 19:00 and 07:00.

12.7 RESIDUAL IMPACTS

The results of ongoing compliance noise monitoring undertaken as part of the facilities existing IED Licence in addition to specific noise calculations associated with the facilities key sources have confirmed that noise levels associated with the operation of the Drehid WMF at the nearest sensitive locations are well below the licensed operational noise criteria in all instances.

Overall, the existing facility has been designed to ensure the operational phase of all sources on the site will not significantly add to the noise environment resulting which results in a slight overall effect. The operational facility impacts on a small number of properties in the immediate boundary to the existing facility. The impacts are continuous, long term and not significant. There are no vibration impacts associated with the operational phase of the existing facility.

12.8 DECOMMISSIONIG IMPACTS

In the event that the facility ceases operation and is decommissioned, a slight reduction in noise levels would occur at the nearest noise sensitive locations compared to those measured and described within Section 12.3.

12.9 DIFFICULTIES ENCOUNTERED

There were no difficulties encountered in the preparation of this Chapter.

12.10 MONITORING

In line with the current IED Licence for the facility, annual noise monitoring is undertaken at the same boundary and noise sensitive locations as part of the annual compliance monitoring schedule. The results are submitted to the EPA for inspection and are included within the facilities Annual Environmental Report (AER).

13 CULTURAL HERITAGE

13.1 BACKGROUND AND OBJECTIVES

Through Time Ltd. (Archaeological Consultants) have been commissioned by TOBIN Consulting Engineers (TOBIN) to assess the potential impacts of the existing facility on the archaeological, architectural and cultural heritage environment. Full details of the existing facility are provided in Chapter 3 (Description of Existing Environment, Ongoing and Future Activities) and are not repeated here.

For the purpose of this report, the impacts of the existing facility on the recorded monuments, architectural and cultural heritage features within the site and in the wider archaeological, architectural and cultural heritage landscape were assessed.

Archaeological heritage generally refers to objects, monuments, buildings or landscapes of an (assumed) age typically older than AD1700 and usually recorded as archaeological sites within the Record of Monuments and Places. The term architectural heritage applies to structures, buildings, their contents and setting of an (assumed) age, typically younger than AD1700. Cultural heritage is applied to other aspects of the landscape such as historical events, folklore and cultural associations and can accompany archaeological and architectural designation.

Details of all recorded monuments and structures both within the existing facility and surrounding it (Table 13.3) are included in Appendix 13.1.

Where appropriate, mitigation measures to limit potentially significant impacts to the archaeological, architectural and cultural heritage are documented, and thereafter residual effects are identified and assessed.

13.1.1 Statement of Authority

Through Time Ltd. is a recently rebranded (2017) archaeological consultancy company that has previously traded as Arch Consultancy Ltd. for almost twenty years. Based in Athenry, County Galway, the company is directed by licensed archaeologists Martin Fitzpatrick M.A. and Fiona Rooney B.A. Both have been involved in all stages of development projects from initial design, compilation of EIAs, archaeological monitoring and resolution during construction. The projects managed ranges from single dwelling houses to impact assessments for large-scale residual landfills, road developments, wind farms and Residual Landfills. Both directors have been involved in the development of residual landfill facilities for almost twenty years from initial design consultations, impact assessments, EIAs and involvement in ensuring that the archaeological and cultural heritage conditions attached to the developments are completed to the highest professional standards. Martin Fitzpatrick, the author of this report, has worked in Irish archaeology for the past 21 years. He is a graduate of NUIG and completed a master's degree specialising in the architecture of 15th/16th century Tower Houses in County Galway. Martin has previously overseen the completion of impact assessments on wind farms, landfill developments and a 60 km motorway development on the M6.

13.1.2 Assessment Structure

This Chapter contains the following sections:

- Assessment Methodology and Significance Criteria – a description of the methods used in baseline surveys and in the assessment of the significance of effects;
- Baseline Description - a description of the cultural heritage of the existing facility site based on the results of desk-based information and a walk over survey;
- Assessment of Potential Effects - identifying the ways in which cultural heritage could be affected by the existing facility, including a summary of the measures taken during design of the facility to minimise any effects;
- Mitigation Measures and Residual Effects - a description of measures recommended to off-set potential negative effects and a summary of the significance of the effects after mitigation measures have been implemented;
- Summary of Significant Effects; and
- Statement of Significance.

13.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

13.2.1 Assessment Methodology

This assessment methodology has involved the following elements, further details of which are provided in the following sections:

- Legislation and guidance review;
- Desk study, including review of available maps and published information;
- Site walkover;
- Evaluation of potential effects;
- Evaluation of the significance of these effects; and
- Identification of measures to avoid and mitigate potential effects.

The methodology used in this assessment is based on the EPA *Advice Notes on Current Practice (in the preparation of Environmental Impact Statements)*[35] (EPA, 2003) on Cultural Heritage, including folklore/tradition, architecture/settlements and monuments/features, following a baseline study of the existing cultural heritage features in the area of the existing facility, as well as per the Institute of Archaeologists (IAI) *Good Practice Guidelines*. The updated *Advice Notes for Preparing Environmental Impact Statements (Draft)*[36] (September 2015) have also been used.

13.2.2 Relevant Legislation & Guidance

Archaeological monuments are protected through national and international policy designed to secure the protection of the cultural heritage resource. This is facilitated in accordance with the provisions of the

[35] https://www.epa.ie/pubs/advice/ea/guidelines/EPA_advice_on_EIS_2003.pdf
[36]https://www.epa.ie/pubs/consultation/reviewofdrafteisguidelinesadvicenotes/Draft%20Advice%20Notes%20for%20preparing%20an%20EIS.pdf

European Convention on the Protection of the Archaeological Heritage (Valletta Convention), which was ratified by Ireland in 1997.

The National Monuments Act 1930 to 2004 and relevant provisions of the National Cultural Institutions Act 1997 are the primary means of ensuring the satisfactory protection of archaeological remains, which includes all man-made structures of whatever form or date except buildings habitually used for ecclesiastical purposes. A National Monument is described as:

> *"a monument or the remains of a monument the preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic or archaeological interest attaching thereto" (National Monuments Act 1930 Section 2)."*

A number of mechanisms under the National Monuments Act are applied to secure the protection of archaeological monuments. These include the Register of Historic Monuments, the Record of Monuments and Places and the placing of Preservation Orders and Temporary Preservation Orders on endangered sites.

The Minister may acquire National Monuments by agreement or by compulsory order. The State or the Local Authority may assume guardianship of any National Monument (other than dwellings). The owners of National Monuments may also appoint the Minister or the Local Authority of that monument if the State or Local Authority agrees. Once the site is in ownership or guardianship of the State, it may not be interfered with without the written consent of the Minister.

Section 5 of the 1987 Act requires the Minister to establish and maintain a Register of Historic Monuments. Historic monuments and archaeological areas present on the Register are afforded statuary protection under the 1987 Act. Any interference with sites recorded on the Register is illegal without the permission of the Minister. Two months' notice in writing is required prior to any work being undertaken on or in the vicinity of a Registered Monument. The Register also includes sites under preservation orders and temporary preservation orders with the written consent, and at the discretion of the Minister.

Section 12 (1) of the 1994 Act requires the Minister to establish and maintain a Record of Monuments and Places where the Minister believes that such monuments exist. The Record comprises a list of monuments and relevant places and map(s) showing each monument and relevant place in respect of each county in the state. All sites recorded on the Record of Monuments and Places receive statuary protection under the National Monuments Act 1994.

Section 12(3) of the 1994 Act provides that:

> *"Where the owner or occupier (other than the Minister) of a monument or place included in the Record, or any other person, proposed to carry out, or to cause or permit the carrying out of, any work at or in relation to such a monument or place, he or she shall give notice to the*

Minister to carry out work and shall not, except in the case of urgent necessity and with the consent of the Minister, commence the works until two months after the giving of notice".

The Architectural Heritage and Historic Properties Act 1999 and the Planning and Development Act of 2000 are the main built heritage legislation. The Architectural Heritage Act requires the Minister to establish a survey to identify, record and assess the architectural heritage of the country. The National Inventory of Architectural Heritage (NIAH) records all built heritage structures within specific counties in Ireland. The document is used to advise Local Authorities on the register of a Record of Protected Structures (RPS) as required by the Planning and Development Act, 2000.

The Act of 2000 requires Local Authorities to establish a Record of Protected Structures to be included in the County Development Plan (CDP). Buildings recorded in the RPS can include Recorded Monuments, structures listed in the NIAH or buildings deemed to of architectural, archaeological or artistic importance by the Minister. Once listed in the RPS, the sites/areas receive statuary protection from injury or demolition under the 2000 Act. Damage to or demolition of a site registered in the RPS is an offence. The detail of the list varies from County to County. If the Local Authority considers a building to be in need of a repair, it can order conservation and/or restoration works. The owner or developer must make a written application/request to the Local Authority to carry out any works on a protected Structure and its environs.

Fieldwork for the NIAH for County Kildare was undertaken in 2003. Where an NIAH survey has been carried out, those structures which have been attributed a rating value of international, national or regional importance in the inventory are recommended by the Minister of Culture, Heritage and the Gaeltacht to the relevant planning authority for inclusion on the RPS. In accordance with Section 53 of the Planning and Development Act 2000, if a planning authority, after considering a recommendation made to it under this section, decides not to comply with the recommendation, it shall inform the Minister in writing of the reason for its decision.

13.1.1.1 Kildare County Development Plan 2017-2023

Kildare County Council (KCC) has written policies on the preservation of structures, or part of structures, which are of special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest. Their aim is:

"To protect, conserve and manage the archaeological and architectural heritage of the county and to encourage sensitive sustainable development so as to ensure its survival and maintenance for future generations."

Archaeological Heritage AH1-AH9:

"It is the policy of the Council to:

- *Manage development in a manner that protects and conserves the archaeological heritage of the county, avoids adverse impacts on sites, monuments, features or objects of significant historical or archaeological interest and secures the preservation in-situ or by record of all sites and features of historical and archaeological interest. The Council will favour preservation in–situ in accordance with the recommendation of the Framework and Principals for the Protection of Archaeological Heritage (1999) or any superseding national policy.*
- *Have regard to the Record of Monuments and Places (RMP), the Urban Archaeological Survey and archaeological sites identified subsequent to the publication of the RMP when assessing planning applications for development. No development shall be permitted in the vicinity of a recorded feature, where it detracts from the setting of the feature or which is injurious to its cultural or educational value.*

- *Secure the preservation (in-situ or by record) of all sites, monuments and features of significant historical or archaeological interest, included in the Record of Monuments and Places and their settings, in accordance with the recommendations of the Framework and Principles for the Protection of Archaeological Heritage, DAHG (1999), or any superseding national policy document.*
- *Ensure that development in the vicinity of a site of archaeological interest is not detrimental to the character of the archaeological site or its setting by reason of its location, scale, bulk or detailing and to ensure that such proposed developments are subject to an archaeological assessment. Such an assessment will seek to ensure that the development can be sited and designed in such a way as to avoid impacting on archaeological heritage that is of significant interest including previously unknown sites, features and objects.*
- *Contribute towards the protection and preservation of the archaeological value of underwater or archaeological sites associated with rivers and associated features.*
- *Contribute towards the protection of historic burial grounds within the county and encourage their maintenance in accordance with conservation principles in co-operation with the Historic Monuments Advisory Committee and National Monuments Section of Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs (DAHRRGA).*
- *Promote and support in partnership with the National Monuments Section of the Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs (DAHRRGA), the concept of Archaeological Landscapes where areas contain several Recorded Monuments.*
- *Encourage, where practicable, the provision of public access to sites identified in the Record of Monuments and Places under the direct ownership, guardianship or control of the Council and/or the State.*
- *Encourage the provision of signage to publicly accessible recorded monuments".*

The following is a summary of the relevant Architectural Heritage section PS1-PS21:

"It is the policy of the Council to:

- *Conserve and protect buildings, structures and sites contained on the Record of Protected Structures of special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest.*
- *Protect the curtilage of protected structures or proposed protected structures and to refuse planning permission for inappropriate development within the curtilage or attendant grounds of a protected structure which would adversely impact on the special character of the protected structure including cause loss of or damage to the special character of the protected structure and loss of or damage to, any structures of architectural heritage value within the curtilage of the protected structure. Any proposed development within the curtilage and/or attendant grounds must demonstrate that it is part of an overall strategy for the future conservation of the entire built heritage complex and contributes positively to that aim.*
- *Require that new works will not obscure views of principal elevations of protected structures.*
- *Promote best practice and the use of skilled specialist practitioners in the conservation of, and any works to, protected structures. Method statements should make reference to the DAHG Advice Series on how best to repair and maintain historic buildings. As outlined in the Architectural Heritage Protection Guidelines, DAHG, a method statement is a useful tool to explain the rationale for the phasing of works. The statement could summarise the principal impacts on the character and special interest of the structure or site and describe how it is proposed to minimise these impacts. It may also describe how the works have been designed or specified to have regard to the character of the architectural heritage.*
- *Protect and retain important elements of the built heritage including historic gardens, stone walls, landscapes and demesnes, and curtilage features.*
- *Require where appropriate that a Conservation Plan is prepared in accordance with DAHG Guidelines and conservation best practice to inform proposed visual or physical impacts on a Protected Structure, its curtilage, demesne and setting.*
- *Have regard where appropriate to DAHG Guidelines and conservation best practice in assessing the significance and conservation of a Protected Structure, its curtilage, demesne and setting.*
- *Have regard where appropriate to DAHG Guidelines and conservation best practice in assessing the impact of development on a Protected Structure, its curtilage, demesne and setting."*

13.2.3 Desk Study

This involved an examination of the archaeological, historical and cultural heritage context of the area in general and specifically the existing facility site. The assessment is divided into two separate phases. Phase I involved a paper survey of archaeological, historical, architectural, cultural heritage and cartographic sources.

The following sources were examined as part of the assessment:

- Record of Monuments and Places (RMP) for County Kildare;
- Sites and Monuments Record (SMR) for County Kildare;
- The Archaeological Inventory for County Kildare;
- Topographical files of the National Museum of Ireland;
- Kildare County Development Plan 2017-2023;
- National Inventory of Architectural Heritage;
- First edition ordnance survey maps;
- Second edition ordnance survey maps;
- Third edition ordnance survey maps;
- Aerial photography;
- Excavation bulletins; and
- Townland Names.

13.2.4 Field Surveys

Walkover surveys of the existing facility and future activities areas were undertaken from 2002 to 2016. The field surveys were completed in advance of planning application submissions and were undertaken to verify the findings of the desk studies and to obtain an understanding of the local archaeological and cultural heritage landscape. This allowed the opportunity of first-hand observation of the terrain, which can often result in the discovery of hitherto unrecorded sites and finds. Not all areas were accessible due to dense vegetation. The existing facility was assessed in terms of landscape, land use, vegetation cover and the presence or lack of both known and potential archaeological sites. The areas surrounding the facility were also field walked at the time of the surveys. A photographic record of the site inspection was compiled.

13.2.5 Predicted Impacts on Archaeological, Architectural and Cultural Heritage

The criteria (EPA, 2002 and EPA, 2003) for the assessment of impacts require that likely impacts are described with respect to their extent, magnitude, type (i.e. negative, positive or neutral) probability, duration, frequency, reversibility, and trans boundary nature (if applicable). The descriptors used in this EIAR are those set out in EPA (2002) *'Glossary of Impacts'*, taking into account the recent draft guidelines on EIA (EPA, 2017).

Impacts may be categorised as follows:

Direct Impacts:

- Archaeological sites can be adversely affected by excavation for development, topsoil stripping for roadways and by the effects of heavy machinery passing over features of archaeological significance;

- Permanent and temporary land-take, landscaping, mounding and general excavations associated with construction may result in the loss or damage of archaeological remains or physical loss to the setting of historical landscapes; and
- The weight of permanent embankments can cause damage to sub-surface archaeological layers and features.

Indirect Impacts:

- Visual impacts on the archaeological landscape can arise from construction. Traffic associated with construction, machinery working, and the noise associated with general construction can impact on the landscape.

No Impact:

- Where the existing facility has neither negative nor a positive impact upon the archaeological and cultural heritage environment.

Positive impacts can also be attributed from development. They may include improved maintenance and access to archaeological monuments and an increase in the level of understanding of an archaeological or historical landscape as a result of archaeological assessments and subsequent fieldwork.

13.1.1.2 Level of Impact

The level of impact on an archaeological, historical or architectural landscape depends on a number of factors which include the existing environment and the type of monument impacted. The level or severity of impact was assessed by taking the following into consideration:

- The proportion of the feature affected and the potential loss of characteristics essential to the understanding of the monument feature or site;
- Consideration of the type, condition, vulnerability and potential amenity value of the landscape, feature, site or monument affected; and
- Consideration of the likely impacts of visual, noise and hydrological alterations which were informed by other specialist reports or observations.

Impacts can be very high, high, medium, low or indeterminable on archaeological, architectural and cultural heritage remains.

Table 13.1: Criteria for Rating Site Attributes

Level of Impact	Significance
Very high	Attribute has a high quality significance or value on a regional or national scale
High	Attribute has a high quality significance or value on a local scale
Medium	Attribute has a medium quality significance or value on a local scale

Low	Attribute has a low quality significance or value on a local scale
Indeterminable	An impact on a feature of unknown archaeological significance

13.1.1.3 Magnitude

The magnitude of potential impacts have been defined in accordance with the criteria provided in the 2002 EPA Publication 'Guidelines on the Information to be contained in Environmental Impact Statements'.

Table 13.2: Impact Assessment Criteria

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

13.3 BASELINE DESCRIPTION

13.3.1 Introduction

This section provides a description of the receiving environment and historical background of the existing facility and wider survey area and is based on the results of the desk based and walk over surveys.

The existing facility is located in Timahoe Bog which is part of Bord na Móna's Allen Group of bogs that were first brought into industrial peat production in the 1950's. Peak production at Timahoe Bog was during the 1960's when the bog was in sod peat production. The peat was removed from the bog via a railway system. Industrial production at the site was gradually phased out over the last fifteen to twenty years as most of the bog was cut away and the poor quality of the remaining peat made further peat harvesting uneconomical. Small scale production for domestic purposes continues at the margins of the commercially cut away bog.

To reduce the moisture content of the peat material during the years of peak industrial activity, it was necessary to drain the entire bog. This was achieved by the excavation of a network of east to west running drains that discharged into a central underground culvert that ran from north to south. The drainage network facilitated heavy plant and machinery to safely traverse the bog. As a result of the drainage channels, the entire site was divided into plots referred to as 'peat fields'. These turf plots span the length of the bog. In some areas they have been exploited to a depth of 0.5 m – 1 m above the natural mineral soil.

An examination of old maps and aerial photographs of the site revealed nothing of archaeological significance. The 1752 map by Noble and Keenan records the Bog of Allen with Timahoe and Drehid marked. The area of the existing facility is indicated as part of the vast bog in this mid-18th century map. Alexander Taylor's map of 1783 similarly depicts the area as a vast bog with the Cashanure River to the west. The first edition ordnance survey map produced in the mid-19th century highlights Coolcarrigan Demesne to the east of the site but no features are indicated in the area of the existing facility. More recent maps and aerial photographs highlight the drainage channels throughout the site. Nothing of archaeological significance is marked in the area of the existing facility on any of the maps or aerial photographs.

13.3.2 Archaeological and Historical Background

Boglands cover one-sixth of the total landmass of Ireland extending over an approximate area of 1.34 million hectares. They can be divided into two major types, raised bogs and blanket bogs, although both appear similar in character the mode of formation differs greatly. The vast majority of Ireland's raised bogs occur in the central lowlands of the country unlike blanket bogs that are predominately confined to mountainous areas and some occasional lowland areas along the western seaboard.

The anaerobic environment of bogs and wetlands helps create unique circumstances for the preservation of remains and have long been known for their rich abundance of archaeological deposits, which can range from the prehistoric to the medieval periods. One of earliest known sites from a wetland context is the Mesolithic habitation from Lough Boora in County Offaly where radiocarbon dating provided a range of dates from 7000-6500 BC.

A number of archaeological artefacts and sites have been recorded to the north of the site. All the identified sites are toghers or trackways, called toghers from the Irish word tógher meaning causeway (Harbison 1988), they invariably transverse bogs at the narrowest crossing point. These trackways can vary significantly in size and form, from simple surface brushwood paths to larger timber planked roadways such as the Corlea trackway in Co. Longford. Some gravel and flagstone examples have also been recorded. The presence of trackways could suggest human activity from as early as the Neolithic period (4000-2500 BC).

The cooler and wetter climatic conditions of the Bronze Age together with the impact of farming on vegetation and, in particular, tree regeneration, led to soils becoming wetter and drainage deteriorated. These conditions facilitated a more rapid increase in the growth and the spread of bogs. Consequently, the crossing of bogs became more difficult and problematic and the archaeological record shows a significant increase in the size and number of toghers constructed during this period. The Bronze Age also saw the deliberate deposition of artefacts as votive offerings in water logged areas and bogs. Boglands have in the past yielded high concentrations of artefacts, particularly Bronze Age flat axes, swords and rapiers. For instance, in north Leinster 48% of Early Bronze Age flat axes have been found in bogs, while in Ireland as a whole, 51% of Late Bronze Age (Dowris Phase) hoards and 59% of later

Iron Age (La Tène Phase) weapons have been recovered from bogs (Cooney and Grogan, 1994). The topographical files of the National Museum of Ireland record a multi-period assemblage of finds for the Timahoe area and surrounding townlands (Section 12.5). Some, such as the bronze rapier from Allenwood Middle, indicate activity for the Middle Bronze Age or Bishopsland Phase.

Human remains or 'bog bodies' have been recovered from wetland sites, the most notable being the exceptionally well-preserved 'Gallagh Man', and more recently an example from Cul na Móna in County Laois. Over eighty burials have been recovered from wetland areas.

Discoveries of bog butter are frequent in Irish bogs, though not entirely an Irish phenomenon, as examples have also been found in Scotland. The practice of burying butter in bogs may possibly date to the sixth century A.D. The preservative properties of the bog would have been ideal for storage, though the desire to produce a special flavour in the butter is a possibility. Containers made from a variety of materials were used to store the butter during its time in the peat, though wooden vessels predominate with some highly decorated examples having been found. Bog butter has also been buried in bark, cloth, wickerwork and animal skin.

Drehid bog is in the barony of Carbury, Co. Kildare. Although usually known as Drehid bog, after Drehid townland, the bog is also known as Timahoe Bog. Timahoe derives its name from Tígh Mochua or the house of Mochua, from the monastery founded here by St. Mochua in the fifth century. The remnants of a church and a well-preserved twelfth-century round tower are all that survive of this monastic settlement. The area had previously been known as Sidh Neachtain or 'The Fairy Hill', a name derived from Nuadha Neacht of Neachtain, who was High King of Ireland for a year, before being slain in 45 AD. The existing permitted development area, to which this EIAR refers, is situated in the townlands of Timahoe West, Coolcarrigan, Killinagh Upper, Killinagh Lower, Drummond, Kileaskin, Loughnacush and Parsonstown.

To the south of the existing facility is the Hill of Allen which also has associations with myths. It was here that *"Almhuin (was) the palace of Fionn Mac Cumhal in Leinster"*, Almhuin being the Hill of Allen. The Annals of The Four Masters records two battles being fought here in 526 AD and 718 AD (O'Donovan 2002, p100). The last reference to Sidh Neachtain was in the Annals of the Four Masters which records the death of Laoghaire, High King of Ireland, at Sidh Neachtain in 458. The area then became known as "Cairbre Og Ciartha" or Carbury. Cairbre was Laoghaires' brother and his dynasty controlled the area until the Norman period when Meider Fitzhenry was granted the Carbury area. Fitzhenry subsequently lost the property in 1181.

The next major holders of the Carbury lands were the Fitzgeralds who were a powerful family in Ireland. The 7th Earl served as Chief Governor of Ireland on a number of occasions. Unfortunately for the Fitzgeralds, their power came to an end because of their involvement in the 1641 rebellion. In the aftermath of the Cromwellian War, Timahoe became the property of the Duke of York, brother of Charles II, who later became King of England, and who was defeated at the Battle of the Boyne in 1690. Subsequently, the property was confiscated and given to two brothers, John and Robert Curtis. They

leased the property to Theobold Burke and Richard Aylmor, who in turn leased it to a group of Quakers from Northern Ireland. They built a meeting house adjacent to their own cemetery and also a windmill nearby.

The bog played an important part in the 1798 rebellion in North Kildare. *"The Prosperous and Clane rebels formed a camp at Timahoe, where it was sited on Hodgestown Hill..."* (Cullen 1998, p13). This was an area of dry land within the bog thus making access almost impossible for English cavalry and artillery. At one point there were almost 2,500 rebels camped there, growing to 4,000 when rebels from Wexford and Wicklow joined them. This latter group moved on however, after just a day, (Ibid, p25).

To the east of the existing facility is Coolcarrigan Demesne which contains a Georgian House built in the 1830's and has a small 19th century Church of Ireland church in the grounds.

13.3.3 Record of Monuments and Places ("RMP")

All known archaeological monuments are indicated on 6-inch ordnance survey maps and are listed in this record. The RMP and the SMR are not complete records as newly discovered sites may not appear. In conjunction with the RMP and SMR, the electronic database of recorded monuments and the files of the Archaeological Survey of Ireland were consulted. Details of Recorded monuments in the townlands surrounding the existing facility are included to highlight the type of sites that survive in the vicinity of the site. The archaeological record indicates one recorded monument (KE008:038) to the immediate south of the existing facility. The site is recorded as an unclassified Roadway. Nothing of the monument survives above ground and the feature is not scheduled for inclusion in the next revision of the Record of Monuments and Places. There are a number of recorded archaeological monuments within Timahoe Bog (Figure 13.5). North of the existing facility two trackways or toghers, (KD009-018 & 019, also known as KD008-029 & 030) are recorded. The monuments were excavated by E. Rynne in the 1960's and by Monroe in 1986, (O'Carroll, 2002). One of the trackways was a substantial oak plank trackway whilst the other was a less substantial birch trackway. Monroe thought that the trackways were broadly contemporary, and the oak plank trackway was dendrochronologically dated in the Middle Bronze Age (1987, 22). A walkover survey conducted in 2002 in preparation for the existing facility found no extant trace of either trackway. Subsequent monitoring of all excavations works associated with the existing facility (License 06E0746) revealed no features of archaeological significance. The Irish Archaeological Wetland Unit identified a further 10 sites in the vicinity of the recorded trackways in the 1990's. Two of these trackways were destroyed before they were plotted (information received from Irish Archaeological Wetland Unit). The trackways were recorded to the north and east of the existing facility and are not impacted. The sites originally recorded by the Irish Archaeological Wetland Unit have, since 2010, been updated to the Sites and Monuments Record available at www.archaeology.ie and are detailed in the table below (Table 13.3).

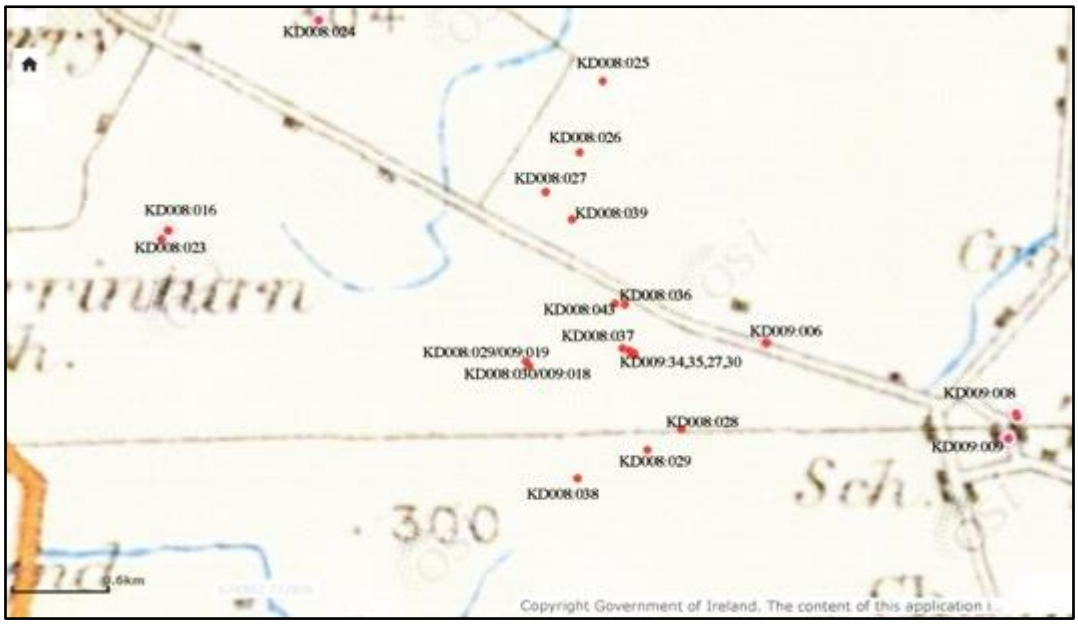


Figure 13.1: Map indicating Recorded Monuments (red dot) in relation to the Existing Facility

Table 13.3: Details of Recorded Monuments within the vicinity of the Existing Facility

Townland	Archaeological Site Type	SMR number	RMP
Parsonstown	Enclosure	KD008:016	YES
Parsonstown	House-indeterminate date	KD008:016001	YES
Parsonstown	Enclosure	KD008:023	YES
Drehid	Moated Site	KD008:024	YES
Drehid	Road Unclassfied Togher	KD008:025/KD009:17	YES
Drehid	Road Unclassfied Togher	KD008:026	YES
Drehid	Road Unclassfied Togher	KD008:027	YES
Timahoe West	Road Class 2 Togher	KD008:036	YES
Coolcarrigan	Road Unclassified Togher	KD008:038	NO
Timahoe West	Road Class 2 Togher	KD008:037	YES
Timahoe West	Peatland Structure	KD008:043	YES
Timahoe West	Road Trackway	KD009:006	YES
Timahoe West	Children Burial Ground	KD009:006001	YES
Coologmartin	Enclosure	KD009:007	YES
Timahoe East	Church & Graveyard	KD009:008	YES
Timahoe West	Castle	KD009:009	YES
Timahoe West	Peatland Structure	KD009:027	NO
Timahoe West	Peatland Structure	KD009:028	NO
Coolcarrigan	Unclassified Road	KD009:029	NO

Timahoe West	Peatland Structure	KD009:030	NO
Timahoe West	Peatland Structure	KD009:034	NO
Timahoe West	Peatland Structure	KD009:035	NO
Parsonstown/Timahoe West	Road Class 1 Togher	KD008:029/KD009:19	YES
Parsonstown/Timahoe West	Road Class 1 Togher	KD008:030/KD009:18	YES
Rathmore	Enclosure	KD008:019	YES
Collinstown	Church Site	KD008:020	YES
Kilpatrick	Burial Ground	KD012:001	YES

13.3.4 Topographical Files for the National Museum of Ireland

This is the archive of all known finds recorded by the National Museum. The archive primarily relates to artefacts but also includes references to monuments and previous excavations. The find locations of artefacts are important contributors to the knowledge of the archaeological landscape. Location information relating to finds is an important indicator of human activity. Topographical files examined for the townlands impacted by the existing facility and areas of ongoing and future activities indicate human activity in the general area from the Neolithic period with many of the artefacts recovered from a peat environment. While the bogs have since been harvested it is possible that further artefacts and/or features survive in the lower levels of peat.

Timahoe and its environs has evidence for the presence of humans possibly dating from the Bronze Age as indicated by the dendrochronological dating of the toghers from Timahoe Bog. However, the recovery of eight axeheads and a flint arrowhead suggests earlier activity dating to the Neolithic period (4000-2000 BC). Artefacts recovered from the area, which are generally found in a bog environment includes leather shoes and portion of a wooden wheel. The area continued to be occupied throughout the medieval period as indicated by the presence of church and castle sites in the vicinity of the existing facility.

The following archaeological artefacts (Table 13.4) are included to highlight the type of archaeological activity in the area and the importance of archaeological monitoring as stray finds are frequently found in the course of monitoring of ground works.

Table 13.4: Archaeological Artefacts Recorded from the Area

Reg No.	Townland	Find Type
1987:72	Allenwood South	Leather Shoe
1987:71	Allenwood South	Bronze Cauldron
1942:1870	Allenwood Middle	Bronze Rapier

1937:2433	Ardkill	Stone Axehead
1937:2438-44	Ballybrack	Stone Implement
1937:2421	Ballybrack	Stone Axehead
1962:75	Ballynakill Lower/Upper	Iron Axehead
-	Ballyteague	Designed Stone
1979:7	Coolcarrig	Wooden Shovel Blade
1979:9	Coolcarrig	Wooden Keg with Bog Butter
1950:31	Demesne	Stone Object
1945:268	Downings	Stone Axehead
1972:355 A&B	Drehid	Bent Wooden Stake
1937:2420	Kileaskin	Stone Axehead
1968:438-439	Kileaskin	2 Polished Stone Axeheads
1994:72	Killinagh	Wood in Bog
1929:1298	Killinagh	Bog Butter
1980:46	Mulgeeth	Wooden Object
1991:44	Mylerstown	Stone Axehead
1987:140	Ticknevin	Leather Shoe
1943:132	Timahoe East	Portion of Wooden Wheel
1938:8560	Timahoe East	Fragment of Large Stone Axehead
1943:286	Timahoe East	Silver Bracelet
1943:130-131	Timahoe East	Wooden Yoke
1950:7	Timahoe East	Iron Axe
-	Timahoe Bog	Bog Body – human forearm
1950:4a, 4b, 4c	Timahoe	3 portions of wooden vessel
1942:409	Timahoe (Derrymahon Bog)	Wooden Object
1978:3	Timahoe East or West	Leather Shoe
1941:1120	Timahoe	Bronze Spearhead
1966:2	Timahoe Bog, Timahoe West	Flint Arrowhead (barbed)

1970:139	Timahoe West	Rough Out
-	Timahoe Bog	Human Skeletal remains
1994:62	Robertstown	Bronze Socketed Axehead

13.3.5 Aerial Photography

The Ordnance Survey of Ireland aerial photographs (www.osi.ie) were consulted to identify any archaeological features in the landscape that may not have been previously recorded. There was no evidence of additional archaeological, architectural or cultural heritage features recorded on the aerial photographs within the area of the existing facility. More recent maps and aerial photographs highlight the drainage channels throughout the bog.

13.3.6 Kildare County Development Plan

The Kildare County Development Plan (2017-2023) was consulted for the schedule of buildings (Record of Protected Structures) and items of cultural, historical or archaeological interest that may be affected by the existing facility. There are no Protected Structures in the area of the existing facility. Coolcarrigan House and Church (Reg. B09-10, B09-11) are both located c. 1.6km to the east. Coolcarrigan House was constructed in the 1830's and was originally used as a shooting lodge. It has extensive gardens and a 19th century Hiberno-Romanesque church on the grounds. A mixed coniferous and deciduous tree belt along the eastern edge of the existing bog ensures that these structures are not visually impacted by the existing facility.

13.3.7 National Monuments in State Care

The Department of Culture, Heritage and the Gaeltacht maintains a database on a county basis of National Monuments in State Care. The term National Monument is defined in Section 2 of the National Monuments Act (1930) as a monument or the remains of a monument:

> *"The preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic or archaeological interest attaching thereto".*

The list contains no National Monuments in State care in the area of the existing facility or the wider area. No National Monuments are impacted by the existing facility.

13.3.8 National Inventory of Architectural Heritage

The NIAH maintains a register of buildings and structures recorded on a county basis. The register indicates that no structures are directly impacted by the existing facility.

13.3.9 Previous Archaeological Work in the Area

To the area immediately north of the existing facility, two trackways or toghers, (KD009-018 & 019, also known as KD008-029 & 030) are recorded. The monuments were excavated by E. Rynne in the 1960's

and by Monroe in 1986 (O'Carroll, 2002). One of the trackways was a substantial oak plank trackway whilst the other was a less substantial birch trackway. Monroe thought that the trackways were broadly contemporary and the oak plank trackway was dendrochronologically dated in the Middle Bronze Age (1987, p22). A walkover survey conducted in preparation for the EIS of the waste management facility in 2002 found no extant trace of either trackway

The Irish Archaeological Wetland Unit identified a further 10 sites in the vicinity of the recorded trackways in the 1990's. Two of these trackways were destroyed before they were plotted (information received from Irish Archaeological Wetland Unit). The trackways were recorded to the north and east of the existing facility and are not impacted by the existing facility. The sites originally recorded by the Irish Archaeological Wetland Unit have, since 2010, been updated to the Sites and Monuments Record available at www.archaeology.ie and are detailed in the table below.

Monitoring of all excavations works associated with the development at the site in 2006 (License 06E0746) revealed no features of archaeological significance (Turrell & Flood, 2007). Between 2008 and 2010 further monitoring was undertaken in advance of the construction of additional landfill cells (Phases 3, 4 & 5) at the existing facility (Turrell, 2009). In 2010-2011, archaeological monitoring associated with the construction of the composting facility and monitoring of Phase 6 of the landfill at the site was undertaken. Construction of further phases of the landfill were monitored between November 2014 and May 2015 (Jane Whitaker, License 06E0746 Ext.). Between January and August 2017 stripping of peat for Phases 13 -15 was monitored by archaeologist Tim Coughlan (License 06E0746-Extension). No finds or features of archaeological significance were encountered in the course of any of this monitoring works.

Following consultation with National Monuments, Department of Culture, Heritage, and the Gaeltacht a survey of the existing drains in the area of the existing facility and proposed future development lands was undertaken. The latter was completed under license (License 16E0467) by Fiona Rooney and Martin Fitzpatrick of Arch Consultancy Ltd. This work involved monitoring the cleaning down of the section face of existing drains to the south of the existing facility to record the stratigraphy and identify any possible archaeological remains. The work was undertaken over a period of ten days in September-October 2016. The monitoring found that in general peat levels throughout much of the site are less than 1 m and, in many places, there is between 0.3-0.5 m of peat deposit remaining above the natural. Off-centre to the south-west of the existing facility produced the deepest levels of peat with up to 2.8 m recorded in an area 100-120 m in length, while peat levels greater than 2 m were also recorded to the south-east. No archaeological features or artefacts were identified in any of the drains examined.

13.3.10 Cartographic Analysis & Ordinance Survey Maps

An examination of old maps and aerial photographs of the subject site revealed nothing of archaeological significance. The 1752 map by Noble and Keenan records the Bog of Allen with Timahoe and Drehid marked. The area of the existing facility is indicated as part of the vast bog in this mid-18th century map. Alexander Taylor's map of 1783 similarly depicts the area as a vast bog with the Cashanure River to the

west. The first edition ordnance survey map produced in the mid-19th century highlights Coolcarrigan Demesne to the east of the site but no features are indicated in the area of the existing facility. More recent maps and aerial photographs highlight the drainage channels throughout the site. Nothing of archaeological significance is marked in the area of the existing facility on any of the maps or aerial photographs.

13.3.11 Townland Names

Townlands are the smallest land divisions in the Irish landscape and many may preserve early Gaelic territorial boundaries that pre-date the Anglo-Norman conquest. The layout of Irish townlands was recorded and standardised by the work of the Ordnance Survey in the 19th century. The Irish translation of townland names often refer to natural topographical features, but name elements may also give an indication of the presence of past human activities within the townland. Table 13.5 provides the possible translation of the Irish origin of the townland names within or adjacent to the existing facility. The townlands of Killinagh Upper, Killinagh Lower and Kileaskin all contain the word Kil or Kill which generally refers to a Church, Monastic Settlement, Churchyard or Graveyard being located in the area. The townland of Parsonstown refers to the place or town of the Parson while Drummond refers to a landscape feature.

Table 13.5: Townlands in the vicinity of Existing Facility Site

Townland	Irish Translation	English Meaning
Timahoe	Tigh Mochua	House of Mochua
Coolcarrigan	Cuil Charraigin	Nook of the little Rock
Ballynakill (Upper & Lower)	Baile na Coille	Town of the Church or Wood
Corduff	Cor Dubh	Black Round Hill

13.3.12 Field Work

Figure 13.2: Digital Global Picture of Existing Facility Site with RMP sites indicated with red dots (After OSI)

The various ordnance survey maps and earlier cartographic sources all identify the area of the Existing Facility as comprising of a vast bogland with no features indicated. The archaeological monitoring undertaken to the south of the existing facility found that in general peat levels throughout are less than 1 m and, in many places, there is between 0.3-0.5 m of peat deposit remaining above the natural.

One recorded monument (KD0008:038) is located to the south of the existing facility. According to the Archaeological Survey of Ireland, this monument is classified as a Road – Unclassified Togher. A togher or tóchar is a brushwood trackway or more usually a roadway constructed from timber beams held in place by wooden pegs, traversing bogland or wetland. Stone-built roads or tracks were also constructed and are known in some cases to connect with wooden trackways. Both the roads of wood and stone construction have a broad date span, with some dating to the Neolithic period, while others are assigned a late medieval date. In many cases, modern roads follow the line of their more ancient antecedents (O'Brien and Sweetman 1997, p51). The Archaeological Survey of Ireland have divided these roads into various classes. The feature located to the south of the existing facility was recorded as measuring 72 m in length, 1 m in width and 0.08 m in depth, consisting of several pieces of hazel brushwood (diam. 0.01-0.025 m) in a haphazard arrangement. Some evidence of burning was recorded, and it is probably the destroyed remains of a more substantial structure. No trace of this feature survives above ground and the monument is not scheduled for inclusion in the next revision of the RMP.

Further togher sites are recorded to the north of the existing facility in the townlands of Parsonstown and Timahoe West (KD008:029/KD009:019, KD008:030/KD009:018). A number of toghers originally identified by the Irish Archaeological Wetland Unit have now been updated to the Record of Monuments and Places included in Table 13.3 above. These sites are located predominantly to the north and north-east of the existing facility in the townlands of Coolcarrigan and Timahoe West and are recorded as unclassified roads, peatland structures and toghers. Further north, togher sites are recorded from the townland of Drehid (KD008:025, KD008:026, KD008:027).

Enclosures are recorded in the townlands of Collinstown (KD008:007), Parsonstown (KD008:023) and Coolmartin (KD009:007) with the closest located c. 3 km from the existing facility. Enclosures are usually distinguished on the basis of their anomalous characteristics, such as their large or small size, or lack of entrance features, which sets them apart from ringforts or other classifiable enclosures. The term usually refers to a site which consists of an enclosing bank surrounding a circular or subcircular area, and with no apparent entrance. Due to the lack of diagnostic remains it is difficult to suggest a period of construction or use for the monuments. Occasionally, the enclosures are surrounded by a ring of trees. The function of these sites is indeterminable from visual inspection alone, that is, without excavation and due to the lack of identifiable features. Sites which are now destroyed but which have been detected on aerial photographs, marked on various Ordnance Survey maps or locally described as circular or subcircular areas defined by banks and/or fosses are usually categorised as enclosures.

A Children's Burial Ground is recorded from Timahoe West (KD009:006.1), c. 2 km to the north-east of the existing facility. These sites are usually found either in isolation or associated with other monuments such as enclosures and are characterised by the presence of numerous small, uninscribed set stones, often arranged in rows.

Following consultation with National Monuments, Department of Culture, Heritage, and the Gaeltacht a detailed survey of the existing drains in the area of the proposed future development lands was undertaken under license (License 16E0467) by Fiona Rooney and Martin Fitzpatrick of Arch Consultancy Ltd. The work was undertaken to the immediate south of the existing facility and involved monitoring the cleaning down of the section face of existing drains to record the stratigraphy and identify any possible archaeological remains. The work was undertaken over a period of ten days in September-October 2016. The monitoring found that in general peat levels throughout much of the site are less than 1 m and, in many places, there is between 0.3-0.5 m of peat deposit remaining above the natural. Off-centre to the south-west the existing facility produced the deepest levels of peat with up to 2.8 m recorded in an area 100-120 m in length, while peat levels greater than 2 m were also recorded in the south-east. No archaeological features or artefacts were identified in any of the drains examined.

Medieval churches, which often incorporate the fabric of early Christian churches, are distinguished on the basis of their ground plan and date. Nave and chancel churches are dated to the twelfth to thirteenth century, while single-celled churches are assigned a thirteenth to seventeenth century date. The single-

celled churches were generally orientated east/west and were entered at the west end of either the north or south wall. Some churches had opposing doorways at the west end of the church. These churches may also have had a subdivision at the west end of the church, in the form of a cross-wall, or the presence of corbels or beam-holes which indicate the former presence of a loft. These quarters comprised the accommodation for the parish priest. A Church and Graveyard is recorded in the townland of Timahoe East (KD009:008) c. 3 km east of the existing facility.

A moated site is recorded in the townland of Drehid (KD008:024) c. 3 km north north-west of the existing facility. These monuments are square, rectangular or occasionally circular areas, sometimes raised above the ground, enclosed by a wide, often water-filled, fosse, with or without an outer bank and with a wide causewayed entrance. They date to the late 13th/early 14th centuries and were primarily fortified residences/farmsteads of Anglo-Norman settlers though also built by Gaelic lords.

Stone castles date to the Anglo-Norman period and would have come after an earlier earth and timber castle, as they took longer to build and were more expensive. A castle was recorded in the townland of Timahoe West (KD009:009) to the north-east of the existing facility, however no surface trace survives today.

13.3.13 Summary

The archaeological assessment identified no archaeological monuments within the existing facility site. All of the sites detailed are recorded in the Record of Monuments and Places and receive statutory protection under the National Monuments Act 1995 (see Section 13.2.2). One recorded archaeological monument (KD0008:038 – A road - Unclassified Togher) is located to the south of the existing facility. No trace of this monument survives above ground and the monument is not scheduled for inclusion in the next revision of the Record of Monuments and Places.

The assessment also identified architectural and cultural heritage features located within the existing facility site and immediate surrounds. No features recorded in the National Inventory of Architectural Heritage are located within the existing facility site. Two structures, recorded in the List of Protected Structures for County Kildare, are located c. 2 km from the existing facility and will not be impacted.

13.4 POTENTIAL EFFECTS TO CULTURAL HERITAGE

Following on from the identification of the baseline environment, the available data is utilised to identify and categorise potential impacts likely to affect the archaeological and cultural heritage environment as a result of the waste facility.

13.4.1 Construction Phase – Direct Impacts

The existing facility has involved the mechanical excavation of all peat layers down to and through geologically deposited strata to enable ground engineering works such as access roads, cell development and drainage.

The uncovering of sub-surface archaeological features during peat removal associated with the construction has the potential to impact on the archaeological resource. To date no archaeological features or artefacts have been identified in the course of archaeological monitoring of construction.

Machinery tracking over the facility site during construction has the potential to disturb the sub-surface archaeological features, particularly those that have no above ground expression.

Direct impacts of the existing facility on the construction phase can be defined as low, imperceptible.

13.4.2 Construction Phase – Indirect Impacts

The development of the existing facility involved the construction of a large landfill facility, composting building and associated infrastructure. The excavation of a large tract of bog and geological strata had no visual impact on the surrounding archaeological, architectural and cultural heritage landscape. The construction of the existing facility has not impacted on the setting of surrounding monuments.

The impacts on the construction phase are defined as low quality on a local scale and imperceptible, negligible.

13.4.3 Operational Phase – Direct Impacts

The operation of the existing facility has had no direct impacts on the archaeological and cultural heritage resource during the operational phase.

Direct impacts of the existing facility on the operational phase is defined as low, imperceptible.

13.4.4 Operational Phase – Indirect Impacts

The operational phase is concerned primarily with the impact of upstanding structures of the existing facility on the archaeological landscape (i.e. visual and noise). The presence of a landfill facility in the landscape can have a negative impact if located too close to monuments. There is currently no legislation governing the visual impact of a development on recorded monuments, and as such the separation distance between the relevant infrastructure of the development to a recorded monument is not defined.

There is a visual impact on the human landscape. The monuments recorded in proximity to the site have no significant surface element remaining therefore there is no significant visual impact on the setting. The existing facility infrastructure may be visible from surrounding monuments; however, the visual impact of the development is negated by dense vegetation surrounding the site on many sides. An assessment of the visual impacts of the development on the surrounding landscape is detailed in Chapter 8 (Landscape and Visual). The photomontages and zone of theoretical visibility (ZTV) study in Chapter 8 were referred to in this assessment and they indicate that the greatest visual expression will be from the north of the existing facility site. There is a long-term change to the geological and visual character of the site with peat and geological layers being replaced by infrastructure. While some of the existing facility may be visible from the surrounding recorded monuments it should still be possible to view any monument from one side or the other without the waste facility in the background.

Indirect impacts of the existing facility on the operational phase is defined as medium, moderate, small adverse.

13.4.5 Decommissioning Phase – Direct Impacts

No additional direct impacts over and above those identified during construction phase will occur.

13.4.6 Decommissioning Phase – Indirect Impacts

No additional direct impacts over and above those identified during construction phase will occur.

13.5 MITIGATION MEASURE AND RESIDUAL EFFECTS

This sub-section provides a description of measures recommended to off-set potential negative effects identified in Section 13.4 and presents a summary of the significance of the effects after mitigation measures have been implemented.

13.5.1 Construction Phase Impacts

The following mitigation measures were implemented during the construction phase of the existing facility to date and will continue to be implemented in future construction works at the existing facility:

- All ground disturbance associated with the construction of the development were monitored by a suitably qualified archaeologist working under license from National Monuments, Department of Culture, Heritage and the Gaeltacht;

13.1.1.4 Construction Phase Residual Impacts - Direct

No Recorded Archaeological Monument or cultural heritage site is located within the boundary of the existing facility.

Following the imposition of the mitigation measures, the residual direct impacts of the construction phase can be defined as low, imperceptible and negligible.

13.1.1.5 Construction Phase Residual Impacts - Indirect

The construction phase of the Existing Facility involved the excavation of the peat and geological strata and was not visible from the surrounding monuments.

13.5.2 Operational Phase Impacts

Mitigation measures to offset potential indirect impacts were imbedded in the design of the existing facility via the final landscaping design.

13.1.1.6 Operational Phase Impacts - Direct

No direct impacts were predicted during the operational phase of the existing facility on the archaeological, architectural and cultural heritage environment, therefore no mitigation was required.

13.1.1.7 Operational Phase Impacts - Indirect

There may be a visual impact on the setting of archaeological features in the wider environment. This has, where possible, been mitigated by the design of the existing facility.

13.5.3 Decommissioning Phase

No new impacts are predicted during the decommissioning phase of the project on the archaeological, architectural and cultural heritage environment, therefore no mitigation is required.

13.6 CONCLUSIONS

This report was undertaken as an archaeological and cultural heritage impact assessment to be submitted as part of the EIAR for the existing facility. The assessment included desk-based research, on-site field walking and archaeological monitoring to identify areas of archaeological /cultural heritage potential.

There are no Protected Structures in the area of the existing facility or wider landscape. There are no National Monuments in State Care in the area of the existing facility or the wider area. No features of archaeological significance were noted above ground in the walk over survey.

No artefacts or features of archaeological significance were encountered in the survey of section faces of the existing drains.

Archaeological monitoring of all ground disturbance associated with the existing facility revealed no finds or features of archaeological significance.

The mitigation measures proposed here are subject to ratification by National Monuments, Department of Culture, Heritage and the Gaeltacht.

13.7 STATEMENT OF SIGNIFICANCE

Given that only effects of significant impact or greater are considered “significant” in terms of the EIA Regulations, the potential effects of the existing facility on the archaeological, architectural and cultural heritage resources are considered to be not significant.

13.8 SUMMARY OF SIGNIFICANT EFFECTS

This assessment has identified no potentially significant effects from the existing facility on the receiving environment.

14 CLIMATE

14.1 INTRODUCTION

This Chapter assesses the effect on climate arising from the existing waste management facility located at Carbury, County Kildare.

14.1.1 Methodology

A desk-top assessment of available climatic information was undertaken to characterise the existing climate. Meteorological data contained in this Chapter has been received from Met Éireann and from the Lullymore rainfall station (Bord na Móna). All calculations detailed in the report are carried out using methods advised by Met Éireann.

14.1.2 Weather Observing Stations

14.1.1.1 Rainfall Stations

There are numerous rainfall measuring stations throughout the country, which measure the local daily rainfall in millimetres (mm). Some of these stations also measure additional parameters such as soil moisture, temperature and humidity.

14.1.1.2 Synoptic Stations

Synoptic stations observe and record surface meteorological data. These observations include rainfall, temperature, wind speed and direction, relative humidity, solar radiation, clouds, atmospheric pressure, sunshine hours, evaporation and visibility. They report a mixture of hourly observations of the weather (synoptic observations) and daily summaries of the weather, known as climate observations. There are 25 No. national synoptic stations [37] and, where required, data have been referenced in this Chapter from relevant synoptic stations, including Casement Aerodrome in South County Dublin and Mullingar synoptic station in County Westmeath.

14.2 RECEIVING ENVIRONMENT/BASELINE DESCRIPTION

14.2.1 General Climate of Ireland

The Atlantic Ocean is the dominant influence on the climate in Ireland. As a result, Ireland does not suffer from extremes in temperature, the average annual temperature being about 9° C. Mean annual wind speed varies between about 4 m/sec in the east midlands and 7 m/sec in the north-west. Strong winds tend to be more frequent in winter than in summer. Sunshine duration is highest in the south-east of the country.

According to Met Éireann and their summary data describing the Climate of Ireland [38], the following observations have been made by the meteorological service. Average annual rainfall varies between about 800 mm and 2,000 mm across the country. With south-westerly winds from the Atlantic dominating,

[37] http://www.met.ie/climate/monthly-data.asp
[38] http://www.met.ie/climate/climate-of-ireland.asp

rainfall figures are highest in the north-west, west and south-west of the country, especially over higher ground. Rainfall accumulation tends to be highest in winter and lowest in early summer. The annual number of days with more than 1 mm of rain varies between about 150 days in the drier parts and over 200 days in the wetter parts of the country.

14.2.2 Rainfall

In order to give reliable climatic data on a particular area, a weather station should be located within 10 km of that area and be in operation for at least 30 years.

A rainfall station is located at Lullymore (Bord na Móna) approximately 4 km southwest of the existing Drehid facility. This station was in operation by Bord na Móna from 1945 to 1992 (47 years) and includes a continuous record of rainfall measurements for 30 years (1960 to 1990), which is considered an appropriate period of measurement to provide reliable data. Rainfall data from the Lullymore (Bord na Móna) station have been reproduced in this Chapter.

The nearest synoptic weather stations with meteorological conditions similar to those found at the existing facility and with a minimum of 30 years operation have been identified as Casement Aerodrome in South County Dublin and Mullingar synoptic station, County Westmeath. These stations are located approximately 30 km east and 40 km west of the existing facility, respectively.

Met Éireann also operate two meteorological stations with more limited climate measurements, but including rainfall measurement, at Edenderry, County Offaly and at Osberstown, County Kildare. In 2010, Met Éireann placed a new rainfall measurement station at the Lullymore Nature Reserve and this station has recorded rainfall from 2011 to date.

Specifics of the location and elevation of the existing development site at Drehid relative to the nearest meteorological stations with recorded rainfall measurements are outlined in Table 14.1.

Table 14.1: Designated Meteorological Stations for the Existing Development

Location	Grid Reference (Irish National Grid (ING))	Elevation (m O.D.)	Height Difference (m)
Existing Development (at Drehid)	274783, 230671 (ING)	85	-
Lullymore (Bord na Móna)	268402, 225010 (ING)	84	-
Casement Aerodrome	303285, 229044 (ING)	94	9
Mullingar	242280; 254331 (ING)	101	16

The elevation of the pre-developed lands at the existing development ranges from approximately 84 to 86 m O.D while the elevation of the rainfall gauge at Lullymore (Bord na Móna) is approximately 84 m O.D. According to Met Éireann, annual precipitation levels increase by 200 – 300 mm per 100 m rise in

elevations [39]. Therefore, no adjustment of the dataset of precipitation levels from the Lullymore (Bord na Móna) has been necessary. The average monthly and annual precipitation levels recorded at Lullymore (Bord na Móna) are considered to be representative of the existing site location. Average monthly rainfall levels from the Lullymore rainfall station (Bord na Móna) are given in Table 14.2.

Table 14.2: Average Monthly Precipitation Lullymore Rainfall Station (Bord na Móna) 1960-1990

Location	Lullymore (Bord na Móna) Rainfall Station
Height (mOD)	84 m
January	79 mm
February	54 mm
March	60 mm
April	54 mm
May	61 mm
June	63 mm
July	57 mm
August	78 mm
September	71 mm
October	80 mm
November	76 mm
December	83 mm
Annual	**816 mm**

14.2.3 Evapotranspiration and Effective Rainfall

Evaporation is the return of water vapour to the atmosphere. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through stomata in its leaves.

Potential Evapotranspiration (PE) refers to the amount of water that could potentially be removed from the soil, through evaporation from land and through transpiration by plants, assuming sufficient water is always available within the soil. Actual evapotranspiration is estimated as 95% of potential evapotranspiration to allow for seasonal soil moisture deficits (Misstear and Brown (2008), taken from Tedd et al., 2008) [40].

[39] http://www.met.ie/climate-ireland/rainfall.asp
[40] https://www.epa.ie/pubs/reports/research/water/kteddinterim/tedd-report-erc-17-chapter2.pdf

The nearest relevant inland synoptic meteorological station with evapotranspiration measuring equipment is located at Mullingar synoptic station.

It can be noted that evapotranspiration recorded at Mullingar is lower during winter months, when temperatures are lower than in summer months, relative humidity is generally higher and plant growth is minimal. The vast majority of evapotranspiration during winter months is attributable to direct evaporation from ground surfaces. During summer months, the rate of evapotranspiration increases and often exceeds the monthly rainfall. This is due to increased free evaporation from the surface and from transpiration from leaves and plants.

Effective rainfall is defined as precipitation minus actual evapotranspiration. The effective rainfall for the existing facility site was calculated using; rainfall data from the Lullymore (Bord na Móna) site, as the estimated rainfall for the existing facility at Drehid, and the potential evapotranspiration data for the nearest relevant inland synoptic station (Mullingar). The calculation of Effective Rainfall at the existing development site is set out in Table 14.3.

Table 14.3: Calculated Effective Rainfall at the Existing Development Site at Drehid

Month	Rainfall (mm)	Potential Evapotranspiration (PE) (mm)	Actual Evapotranspiration (mm)	Effective Rainfall at Existing Facility (mm)
	Rainfall mean at Lullymore (1960-1990)	PE mean at Mullingar synoptic station 1981 to 2010 [41]	(PE x 0.95)	Rainfall-Actual Evapotranspiration
January	79	10.3	9.8	69.2
February	54	17.4	16.5	37.5
March	60	31.0	29.5	30.6
April	54	51.4	48.8	5.2
May	61	71.9	68.3	0.0
June	63	80.5	76.5	0.0
July	57	79.1	75.1	0.0
August	78	65.0	61.8	16.3
September	71	44.0	41.8	29.2
October	80	22.9	21.8	58.2
November	76	10.3	9.8	66.2
December	83	7.5	7.1	75.9
Total	**816.0**	**491.3**	**466.7**	**388.2**

[41] http://www.met.ie/climate/monthly-data.asp?Num=875

Any rain falling on the existing facility can evaporate from the surface, infiltrate to the ground or become surface water run-off. The surface water drainage system is discussed in more detail in Chapter 7 (Water).

14.2.4 Wind

Wind data from Casement Aerodrome was used for the assessment of wind conditions at the existing facility.

The Casement Aerodrome wind rose diagram shows that the prevailing winds are from the south-west [42]. (refer to Appendix 14.1 *Casement Aerodrome Wind Rose Diagram* for further details). Based on the averages between 1981 and 2010, the mean wind speed at Casement Aerodrome [43] is 10.7 knots (5.5 m/s) while the maximum gust reached 82 knots (42.2 m/s). The mean number of days with gales during these years was 18.1 days. The elevation of the meteorological anemometer is approximately 94 m OD. These wind speeds are likely to be indicative of those at the existing facility in Drehid.

14.2.5 Likely future receiving environment/ do nothing scenario

In this context, the Do-Nothing Scenario represents the ongoing operation of the Drehid WMF in accordance with the existing IED Licence. The existing facility will continue to develop in accordance with existing permissions in place as outlined in Chapter 3 (Description of the Existing Environment, Ongoing and Future Activities).

14.3 POTENTIAL EFFECTS ON CLIMATE

According to the Irish Peatlands Preservation Council, in their natural state, peatlands act as long-term sinks for atmospheric carbon dioxide. Drainage of a peatland upsets the accumulation process and leads to a vast increase in the amount of carbon dioxide released to the atmosphere from the peatland [44]. The existing Drehid facility was not, however, developed on intact bog. As part of site investigations carried out on the bog adjacent to the existing facility, based on the Von Post scale, the surface peat varies from H2 to H7 and is predominantly Dry (B1 to B2) (refer also to Chapter 6 (Soils and Geology)). It is considered therefore, that the existing facility does not significantly effect the environment by draining the peatland.

During the operational phase of existing facility, the potential negative effects are environmental risks associated with emissions to the atmosphere and to water (namely dust, odours and gas, such as CO_2 and CH_4, and water contamination by leachate, if not controlled). There is the potential for a number of greenhouse gas emissions to atmosphere during the operational phase of the development and cumulative developments including the MBT (potential cumulative effects from the MBT and proposed future development works at the site are considered in the Proposed Development EIAR). Potential effects on climate due to the traffic include regional or transboundary impacts. Road traffic may give rise to CO_2, NO_x and VOCs emissions. These emissions to atmosphere were assessed in Chapter 11 (Air

[42] 1971 to 2000 data
[43] http://www.met.ie/climate-ireland/1981-2010/casement.html
[44] http://www.ipcc.ie/a-to-z-peatlands/peatland-action-plan/climate-change-and-irish-peatlands/

Quality) using the UK Design Manual for Roads and Bridges screening model which is a recommended screening model for assessing the effect of traffic. The inputs to the air dispersion model consisted of information on road layouts, receptor locations, annual average daily traffic movement's, annual average traffic speeds and background concentrations.

The effect of the current and ongoing activities at the existing facility on national greenhouse gas emissions is insignificant in terms of Ireland's obligations under the EU 2020 Target and Ireland's obligations under the Targets set out by *'Proposal for a Directive on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35/EC'*. The effects are determined to be imperceptible and long-term.

The potential effects due to emissions to the atmosphere and to water have, however, been offset during the design and ongoing operational phase. Modern landfills, including the existing operational landfill at Drehid, are engineered to prevent leachate escaping and to collect landfill gas and emissions. Leachate and landfill gas management are discussed in detail in Chapter 3 (Description of the Existing Environment, Ongoing and Future Activities) and are managed in accordance in accordance with the requirements of the existing IED Licence for the facility.

Furthermore, as noted below, the stabilisation of biodegradable waste is carried out at the existing facility. The composting process provides environmental benefit through the treatment of the organic waste. Methane is a harmful greenhouse gas if it escapes to atmosphere and, by virtue of the process in the composting facility, biodegradable municipal waste is biostabilised, thereby minimising its potential to generate methane and controlling the leachate generation from the waste.

The existing composting facility at Drehid is currently permitted to accept 25,000 TPA of biodegradable waste. This activity is of benefit to Ireland in reaching targets under the Landfill Directive (1993/31/EC) which set a maximum of 427,000 tonnes of biodegradable municipal waste to be landfilled by July 2016 [45]. In July 2016, Ireland notified the European Commission of its intention to avail of the derogation for the 2016 target i.e. to defer the fulfilment of the target from 2016 to 2020. It is noted that Bord na Móna have sought planning permission to increase the capacity of the facility to accept biodegradable waste (as set out in detail in the Proposed Development EIAR) which will further support the country's ability to meet the 2020 target set out above.

14.4 MITIGATION MEASURES

As the facility is currently operational, ongoing monitoring is carried out in accordance with the existing IED Licence to ensure no contamination or emissions occur that could affect the wider environment.

[45] http://editions.sciencetechnologyaction.com/lessons/6/94/EPA.pdf

As discussed in Chapter 11 (Air Quality), an odour abatement system, including building ventilation, is installed in the composting facility and has been designed in accordance with Best Available Techniques (BAT) to mitigate potential air quality effects.

Gas emissions from the existing landfill are captured and treated in the landfill gas utilisation plant where it is used as a fuel to generate electricity. This process is managed on a continuous basis by Bord na Móna and is optimised in accordance with variances in the landfill gas composition, as required. Similarly, leachate generated in the landfill is collected and directed to the leachate collection tanks where a portion is treated using RO technology and the remainder is removed from site to an appropriate WWTP.

14.5 CONCLUSION

The potential for negative effects to occur, in relation to climate, as a result of the current and ongoing activities at the existing facility, has been evaluated as being insignificant. The existing facility is located in an area of previously degraded and harvested bog that has become a built environment and has lost its potential as a carbon sink.

The existing facility is designed and operated to meet all relevant standards and minimise any potential risks of contamination or emissions from the site. The operations of the existing facility are carried out in full compliance with the requirements of the IED Licence issued by the EPA.

15 POPULATION AND HUMAN HEALTH

15.1 INTRODUCTION

This Chapter assesses the existing environment in addition to the potential effects on population and human health arising from the ongoing and future operations of the existing facility.

Section 15.2 of the Chapter will focus on Population including land use, population, employment, tourism and amenities, infrastructure, community gain and health and safety. Measures that are currently in place to mitigate any potential effects arising from the operation of the existing facility will be set out. The second part of this chapter (Section 15.3) will specifically deal with the potential effects on human health associated with the ongoing and future operations of existing facility. This will include a human health risk assessment which is the process to estimate the nature and probability of adverse health effects in humans as a result of the activities at the existing facility.

15.2 POPULATION

15.2.1 Methodology

A desktop study was carried out in order to examine relevant information pertaining to socio economic activity in the area. The following information sources and references were used to compile this Chapter:

- EPA, *Guidelines on the Information to be contained in Environmental Impact Statements* (March 2002);
- EPA, *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements* (September 2003);
- EPA, *Guidelines on the information to be contained in Environmental Impact Assessment Reports (Draft)* (August 2017);
- EPA, *Advice Notes for Preparing Environmental Impact Statements (Draft)* (September 2015);
- Fáilte Ireland information in relation to tourism amenity in conjunction with websites of relevant tourism sites and amenities for the area;
- Central Statistics Office (CSO) information;
- KCC, *Kildare County Development Plan 2017-2023* (2017);
- Guidelines on the treatment of tourism in an EIS, provided by Fáilte Ireland as part of their submission to the Scoping request issued to them;
- OSI mapping and Aerial Photography to identify land use and possible amenity sites; and
- Relevant EIS and EIARs prepared for developments within the Bord na Móna landholding (2004, 2008, 2012 and 2017).

15.2.2 Receiving Environment/Baseline Description

The extent of the Bord na Móna landholding, which comprises 2,544 hectares (ha), is outlined in blue in Figure 1.1 in Chapter 1 (Introduction). The overall landholding is located within the townlands of Drehid, Ballynamullagh, Kilmurry, Mulgeeth, Mucklon, Timahoe East, Timahoe West, Coolcarrigan, Corduff,

Coolearagh West, Allenwood North, Killinagh Upper, Killinagh Lower, Ballynakill Upper, Ballynakill Lower, Drummond, Kilkeaskin, Loughnacush and Parsonstown at Carbury, County Kildare.

The existing licensed waste facility, to which this EIAR refers, is confined to an area of 179 ha and is outlined in red on the Regional Site Location Map in Figure 1.1. The development is situated in the townlands of Timahoe West, Coolcarrigan, Killinagh Upper, Killinagh Lower, Drummond, Kilkeaskin, Loughnacush, and Parsonstown.

The village of Derrinturn is located approximately 3 km to the north-west and Timahoe crossroads is located approximately 2 km to the east.

The land within the red line boundary consists of a MSW landfill, composting facility, administration area, car park, access roads, weighbridge, settlement lagoons and ancillary infrastructure. The remaining areas around the existing facility within the Bord na Móna land holding consist of the flat lying and gently undulating topography typical of cut away peatland.

Figure 1.1 shows the site location relative to a number of adjacent villages including Derrinturn, Timahoe, Coill Dubh and Allenwood at a scale of 1:25,000. The location of the site boundary relative to the regional roads R402 and R403 is also shown.

15.2.2.1 Land Use

The existing permitted facility is located within the overall Bord na Móna landholding. This property is located between the Regional Routes R403 (Lucan/Carbury) and R402 (Enfield/Tullamore) that lie to the south and west of the site, and County Roads L5025 and L1019 located to the north and east of the site.

Ongoing waste activities at the facility consist of the landfilling of MSW material and acceptance of suitable organic waste for composting. The existing facility also provides for ancillary infrastructure to support the above activities. Land use on and adjacent to the existing facility site is primarily disused cutaway bogland used up to approximately twenty-two years ago for production of sod peat for energy generation. Immediately adjacent to the site there are areas of land where turbary, commercial forestry and agricultural usage are evident. The adjacent lands consist of cutover bog with a mosaic of bare peat and revegetated areas with scrub, woodland, heath and grassland communities present.

The facility is located within a mixed rural/urban setting at the north-western extent of County Kildare. Within the extended area, farming enterprises intermingle with a multiplicity of industrial and commercial establishments as well as a number of settlements that have developed primarily along a section of the existing national road system.

A detailed topographical survey was carried out on lands around the site in March 2016. The final output of this survey is presented as a topographic contour map on Drawing No. 10369-2000. The existing facility is situated in relatively flat low-lying cutaway bogland with pre-development levels ranging from 84 m to 86 mOD. Whilst the topography throughout the overall landholding is also relatively flat at 80 to 90 mOD,

screening of the site operations from the adjoining roads are provided by existing hedgerows and tree lines.

As detailed in Chapter 2 (Planning and Policy), the existing facility is located within the 'Western Boglands' Landscape Character Area as set out in the Kildare CDP 2017-2023. The Western Boglands are listed as Class 3 with a High Sensitivity rating. See Chapter 8 (Landscape and Visual) for further details of the landscape assessment.

15.2.2.2 Population

This section provides an overview of the population change over the period 2006 – 2016 in order to gain an understanding of the socio economic activity in the area. The Bord na Móna landholding is located in the Electoral Divisions (EDs) of Timahoe North, Timahoe South, Drehid, Dunfierth, Kilpatrick, Windmill Cross and Kilmeage North. The existing facility is located within the ED of Timahoe North, Timahoe South, Kilpatrick and Windmill Cross. According to S.I. No. 52/2014 - County of Kildare Local Electoral Areas and Municipal Districts Order 2014, these EDs are located within the Electoral Areas of Kildare-Newbridge and Maynooth.

The objectives for settlements immediately adjacent to the subject site are outlined in Section 3.3 of the Kildare CDP 2017-2023, in accordance with the Regional Planning Guidelines for the Greater Dublin Area 2010-2022. Allenwood and Coill Dubh/Coolearagh are described as *Villages,* Prosperous and Derrinturn are *Small Towns*, while Carbury and Timahoe are categorised as *Rural Nodes*.

As described in the CDP (Section 3.4.3), the role of a Small Town is to develop as a key local centre for services for a population of roughly 1500 to 5000, to cater for local need and support local enterprise. As described in Section 3.4.4, the role of a Village is to develop as a local centre for services and to cater for local need and enterprise at an appropriate scale, with limited scope for expansion.

As the existing permitted facility remains outside the development boundary of Derrinturn and Allenwood, specific planning objectives relating to these settlements do not apply.

All of the existing settlements in the vicinity are at a considerable distance from the subject site, the nearest being Timahoe, at c. 2 km from the existing facility boundary. Derrinturn is c. 3 km to the north-west of the existing facility boundary, while both Allenwood and Coill Dubh are in excess of 3 km from the main waste infrastructure.

Table 15.1 illustrates the population change between 2006 and 2016 in the State, Provence, County and the EDs of Timahoe North, Timahoe South, Kilpatrick and Windmill Cross.

Table 15.1: Population Change 2006-2016

Location	2006	2011	2016	% Change 2006-2016
State	4,239,848	4,588,252	4,761,865	12.3%
Leinster	2,295,123	2,504,814	2,634,403	14.7%
County Kildare	186,335	210,312	222,504	19.4%
Timahoe North	988	1,089	1,161	17.5%
Timahoe South	722	772	845	17.0%
Kilpatrick	841	866	871	3.6%
Windmill Cross	882	1,137	1,182	34.0%

Source: Central Statistics Office (CSO) 2016 Census (Accessed on 18 July 2018)

Table 15.1 above shows that the population has increased in the state as a whole and in Leinster over the period 2006 – 2016 by 12.3% and 14.7% respectively. Population during this period has increased significantly in County Kildare, by 19.4%. Population also increased within the EDs of Timahoe North (17.5%) and Timahoe South (17.0%) at a similar rate. There was a much lower population increase in the ED of Kilpatrick (3.6%) and much higher increase in the ED of Windmill Cross (34%).

The Kildare CDP 2017-2023 notes the key trends which have been observed during the 2006 – 2011 period (Section 3.2) which included the following:

"*The period showed continued increase in population at an average rate of 4,795 persons per annum over the five years, representing a slight decrease in the average of 5,598 over the preceding four years (2002-2006).*

The greatest growth in population in the County's urban areas was in Newbridge with an increase in population of 4,519 persons, followed by Celbridge (2,275), Maynooth (1,795), Clane (1,734), Sallins (1,477) and Kilcock (1,433).

Continued pressure for development at the edges of the County's main urban centres and in the adjoining rural hinterlands.

A limited number of areas experienced population stagnation including north of Rathangan, south of Ballymore Eustace, Newbridge town centre, Pollardstown, Ballysax, west Athy and south of Maganey'.

Table 15.2: Population Change 2006-2016

Location	2006	2011	2016	% Change 2006-2016
Maynooth	38,635	46,037	50,842	31.6%
Kildare-Newbridge	48,807	50,106	52,718	8.0%

Source: Central Statistics Office (CSO) 2016 Census (Accessed on 18 July 2018) (Based on S.I. No. 52 of 2014 Schedule of Local Electoral Areas)

Table 15.2 above shows the population change of the new Local Electoral Areas in County Kildare which were changed in 2014 (by S.I. No. 52 of 2014 Schedule of Local Electoral Areas). As the Electoral Areas have recently been changed, there is no direct comparison available to data from previous censuses. As an exercise to allow comparison with previous years data, the individual population data available from CSO for the pre-2014 Electoral Areas was summed to give comparable population figures for 2011 and 2006 for the new Local Electoral Areas.

Table 15.2 shows that the population has significantly increased in Maynooth Local Electoral Area over the period 2006 – 2016 (31.6%) and to a lesser extent in the Kildare-Newbridge Local Electoral Area (8%).

The Quarterly National Household Survey (QNHS) release has been replaced by the Labour Force Survey (LFS) release from Q3 2017. Table 15.3 presents the findings from the QNHS in Q1 2017 against the findings from the LFS in Q1 2018 to illustrate the changes in unemployment rate and participation rate over the previous 12 months.

Table 15.3: Labour Force Survey* (Q1 2017 – Q1 2018)

Time period	State Q1 2017	Mid-East Region Q1 2017	State Q1 2018	Mid-East Region Q1 2018
Unemployment Rate	7.1%	7.2%	5.7%	5.4%
Participation Rate	61.5%	62.9%	61.5%	61.7%

Source: CSO website (Accessed on 19 July 2018)

* Previously known as the Quarterly National Household Survey.

The unemployment rate above is the number of unemployed persons expressed as a percentage of the total labour force. The Q1 2018 unemployment rate for the State was 5.7%, while the unemployment rate for the Mid-East Region was lower at 5.4%. These figures illustrate that there has been a decrease in unemployment throughout the State and the Mid-East Region in the past 12 months.

The participation rate is the number of persons in the labour force expressed as a percentage of the total population (over the age of 15 years. In Q1 2018, the participation rate in the State was 61.5% while the Mid-East Region's participation rate was 61.7%, which is marginally higher than that of the State.

The CSO also publishes figures relating to the Live Register. These figures are not strictly a measure of unemployment as they include persons who are legitimately working part-time and signing on part-time. However, they can be used to provide an overall trend within an area.

Table 15.4: Live Register 2017-2018

Location	January 2017	January 2018	% Change 2017-2018
State	276,892	237,386	-14.2%
Mid-East Region	25,849	22,213	-14.1%
County Kildare	11,207	9,983	-10.9%

Source: CSO website (Accessed on 26 June 2018)

The figures in Table 15.4 show that over the period January 2017 – January 2018 the number of persons on the Live Register decreased in all regions assessed. Although there is a decrease in the number of people on the Live Register, the moderately high number of people still on the Register indicates a need for significant employment opportunities in the area.

Live Register figures for January 2018 and the LFS for Q1 2018 illustrate that unemployment rates remain high throughout the State, the Mid-East Region and County Kildare. This underscores the need for immediate employment opportunities in the area.

15.2.3 Socio Economic Profile

Statistics in relation to occupational groups are provided in the 2016 Census. The no. of males and females employed in the defined occupational groups are presented in Table 15.5 for each of the ED's in which the existing facility is located (i.e. Timahoe North, Timahoe South, Kilpatrick and Windmill Cross).

Table 15.5: Occupational Groups in Electoral Divisions

Occupational Group	Timahoe North		Timahoe South		Kilpatrick		Windmill Cross	
	No. of (M)	No. of (FM)	No. of (M)	No. of (FM)	No. of (M)	No. of (FM)	No. of (M)	No. of (FM)
Agriculture, forestry and fishing	26	7	7	0	15	4	14	11
Building and construction workers	37	6	30	4	33	4	33	6
Manufacturing industries	41	18	25	15	48	11	58	11

Occupational Group	Timahoe North		Timahoe South		Kilpatrick		Windmill Cross	
	No. of (M)	No. of (FM)	No. of (M)	No. of (FM)	No. of (M)	No. of (FM)	No. of (M)	No. of (FM)
Commerce and trade	49	55	56	49	32	36	59	57
Transport and communication	30	8	30	9	18	6	30	9
Public administration	18	16	8	5	6	5	11	7
Professional services	30	77	18	42	17	40	21	61
Other	33	32	21	19	27	18	27	25
Total	**264**	**219**	**195**	**143**	**196**	**124**	**253**	**187**

Source: CSO website (Accessed on 26 June 2018)

Commerce and trade workers are the largest occupational group for males in the Timahoe North, Timahoe South and Windmill Cross. Manufacturing industries are the largest grouping for males in Kilpatrick. Employment in professional services for females in Timahoe North, Kilpatrick and Windmaill Cross is the largest grouping with commerce and trade the largest grouping in Timahoe South.

The aim of economic development as set out in Section 5 of the Kildare CDP 2017-2023 is to *"provide for the future well being of the residents of the county and the region by facilitating economic development; to promote the growth of employment opportunities in all sectors in accordance with the principles of sustainable development; to achieve a reduction in the unsustainable levels of commuting from the county; to provide a greater focus on community building and improving quality of life"*.

It also states that *"Kildare is strategically positioned to benefit from local, national and international markets owing to its location proximate to Dublin and the ports and airports of the GDA. There is also an excellent road and rail network through the county, linking Kildare to important centres of economic, sporting, and cultural activity throughout the State. The county contains a number of employers of significant size including Intel, HP and Maynooth University in north Kildare, Kerry Group in Naas, Pfizer in Newbridge, Bord na Móna in both Newbridge and rural County Kildare, the equine industry and the Defence Forces"*.

15.2.3.1 Proximity of Housing and Centres of Population

Housing in the immediate area of the existing facility comprises predominantly single dwellings with adjacent farmyards and new bungalows. A ground truthing of buildings and planning applications within a buffer of 1 km proximity to the planning application boundary was undertaken on the 14th November 2016. Figure 15.1 shows the outline of the existing facility boundary and a 500 m and a 1,000 m buffer

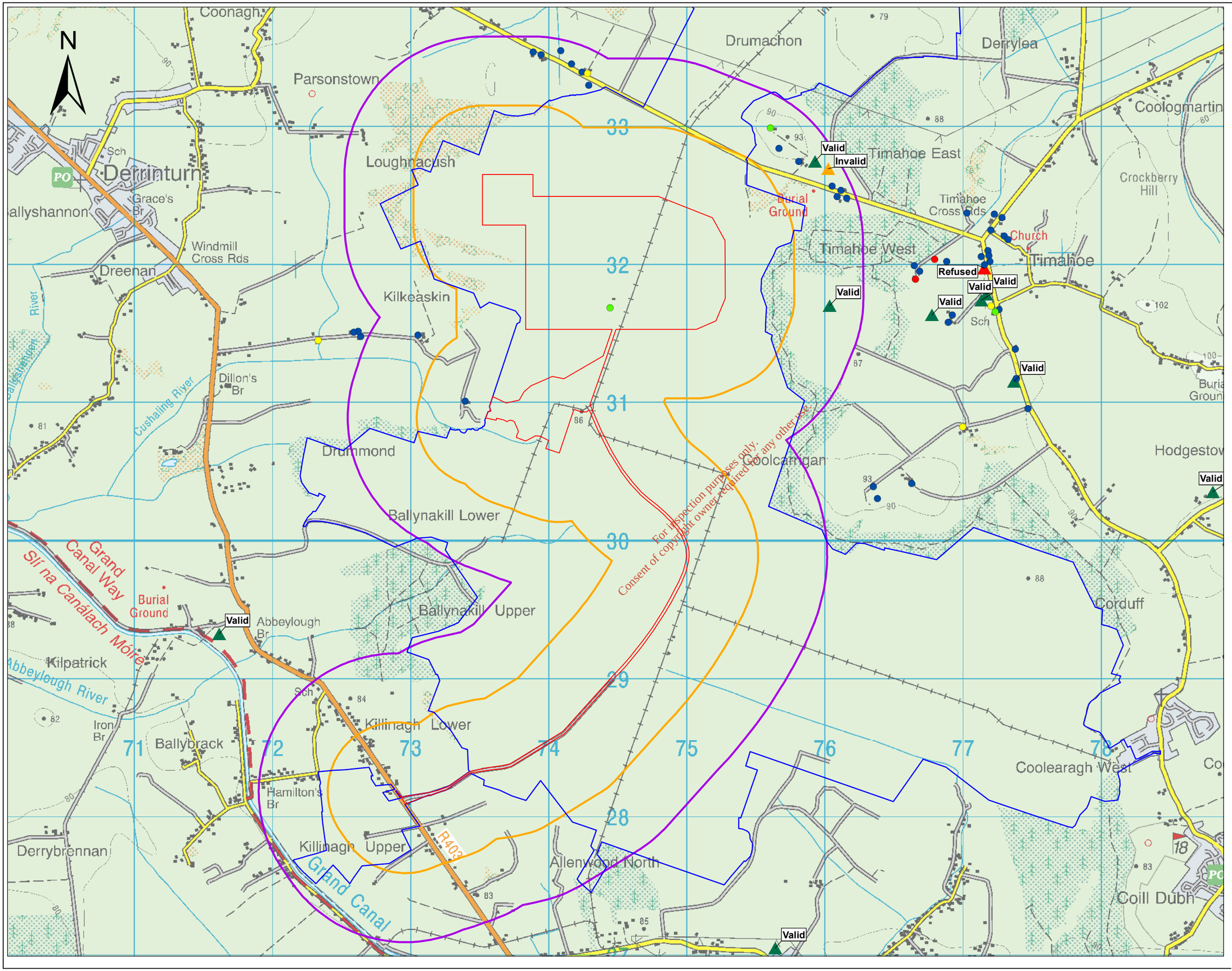
from the planning application redline boundary. The largest concentration of houses close to the existing facility waste activities is to the north-west of the site in the village of Derrinturn.

The nearest sensitive residential receptor is at a distance of c. 970 m to the north-east from the nearest element of the existing landfill infrastructure and at a distance of c. 1,280 m to the south-west from the composting facility.

15.2.3.2 Tourism and Amenities

Section 5.15 of the Kildare CDP 2017-2023 states the following in relation to tourism:

"Tourism is an important sector of Kildare's economy and it has grown substantially over the last number of years…. In the context of tourism, the natural environment, landscape, built heritage and attractive towns and villages play a key role".



Legend

- Site Boundary
- Bord na Móna Ownership Boundary

Buffers

- 1 Km Buffer from Site Boundary
- 500m Buffer from Site Boundary

Dwellings

- Both
- Commercial
- Residential
- Unknown

Planning Applications

- Invalid
- Refused
- Valid

0 125 250 500 750 1,000
Metres

NOTES

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING
2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE
3. ENGINEER TO BE INFORMED OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES
4. ALL LEVELS RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

Issue	Date	Description	By	Chkd.
Rev A	AUG '17	EIAR Issue	F.H	O.McA

Client: Bord na Móna — Naturally Driven

Project: EXISTING DREHID WASTE MANAGEMENT FACILITY

Title: BUILDINGS IN PROXIMITY TO EXISTING FACILITY

Scale @ A3: 1:25,000

Prepared by:	Checked:	Date:
F.Healy	O. McAlister	August 2017

Project Director: D.Grehan

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Rev: A

Figure 15.1

County Kildare is located in the East and Midlands tourist region. Statistics from Fáilte Ireland for the year ending December 2017 (presented in Table 15.6) indicate that approximately 9.022 million overseas visitors arrived in Ireland in 2017 generating total revenue of €4.922 billion. Domestic tourism expenditure amounted to €1.879 billion making tourism a €6.801 billion industry, in total, in 2017.

Table 15.6: 2017 Numbers of Overseas Visitors (thousands of visitors) **

	Britain (000s)	Europe (000s)	N. America (000s)	Other (000s)	Total (000s)	Revenue (€ million)
Visitors to Ireland	3,442	3,258	1,717	606	9,022	€4,922 m
East & Midlands	268	230	94	39	630	€205 m

Source: Fáilte Ireland, Tourism Facts 2017. (Accessed on 19 July 2018)

** Preliminary Results

Table 15.6 illustrates that there were approximately 630,000 overseas visitors to the East and Midlands Region in 2017 and this generated revenue of c. €205 million.

The top visitor attractions identified by Fáilte Ireland for County Kildare for 2010 – 2014 are listed below and included in Appendix 15.1, with associated visitor numbers:

- Newbridge Silverware Museum of Style Icons;
- Castletown House & Parklands;
- Irish National Stud & Japanese Gardens;
- Maynooth Castle;
- Kildare Town Heritage Centre;
- The Steam Museum, Straffan;
- Larchill Arcadian Gardens;
- Leixlip Castle; and
- Ballitore Library & Quaker Museum.

In addition to the top visitor attractions identified above, additional visitor attractions were identified as part of the Tourism assessment and these include:

- Bog of Allen Nature Centre (Lullymore);
- Coolcarrigan House and Gardens;
- The Irish Pewtermill & Moone High Cross Centre;
- Harristown House; and
- A number of golf courses in the wider vicinity.

The Bog of Allen Nature Centre (Lullymore) is located south-west of Allenwood. This centre focuses on Irish Peatland Heritage and all aspects of its history, folklore, nature and wildlife.

Coolcarrigan House has extensive gardens and a 19th century church which are open to visitors. This dwelling is located c. 2 km from the nearest element of the existing landfill infrastructure and is screened from the existing permitted facility by an extensive coniferous forestry plantation to the west of the house. Traffic generated by the existing facility enters the facility directly from the R403 by way of the existing entrance and, therefore, does not adversely impact on visitors travelling to Coolcarrigan House which is accessed from the L1019 to the east.

15.2.3.3 Activities

Walking and Cycling Routes

Section 14.11.3 of the Kildare CDP 2017-2023 states the following in relation to walking routes:

"Two long distance walking routes are located along the Grand and Royal Canals. Both are scheduled for improvement in the coming years. A development by the Council under Part 8 of the Planning and Development Act 2000 (as amended) has been approved to provide a long distance walking route along the Royal Canal between Maynooth and Moyvalley. Other shorter routes are located mainly in urban settings comprising of heritage trails and Slí na Sláinte routes. The eastern uplands, the boglands, the water corridors and disused railway lines coupled with a rich natural, architectural and built heritage provide excellent opportunities to develop further long distance routes (cycling/walking)".

Sections of the Grand Canal Way and the Barrow Way pedestrian walks coincide adjacent to the 19th Lock to the south-east of Allenwood, though both are >5 km from the site boundary.

There is also a walk at Donadea Demense, which has a lake that is home to a variety of wildfowl and is located >8 km from the site boundary.

Forest Parks/Woodlands & Boglands

Section 14.11.3 of the Kildare CDP 2017-2023 states the following in relation to Forest Parks/Woodlands & Boglands:

"Approximately 9,200 hectares of land in Kildare is under forest cover. Forests and woodlands provide benefits over and above the revenue yielded from timber and other wood based products. These include recreational and tourism amenities for local communities…24,300 hectares of peatland cover 14.4% of the county. Of the total bog cover, 10% remains intact, 39% is under industrial peat extraction, 25% consists of cutover and cutaway bog and 24% is modified fen area. Some of these boglands are used for recreation/education purposes such as the Bog of Allen Nature Centre in Lullymore operated by the Irish Peatland Conservation Council and Lullymore Heritage Park".

As stated previously, the Bog of Allen Nature Centre (Lullymore) is located south-west of Allenwood. Ardkill Bog/Ardkill Farm offers visitors a chance to see a raised bog in a controlled setting. These are located approximately 7 km and 5.5 km, respectively, from the existing facility site.

In terms of statutory protection, Carbury and Hodgestown Bogs are designated NHAs and are located approximately 6 km to the north-west and 4 km to the east, respectively, from the existing facility site.

Ballynafagh Lake and Bog are designated SACs and are cited as proposed NHAs. These are located approximately 5.8 km and 6.4 km to the south-east of the site boundary, respectively. The Long Derries, Edenderry is also an SAC and proposed NHA site and is >7 km to the west of the site.

Other Activities

Allenwood Celtic AFC's football pitch is located to the south of the existing entrance on the R403 at Killinagh Upper. A wide belt of mixed deciduous and evergreen trees and shrubs has been planted by the developer along the entire boundary of the Bord na Móna landholding with the grounds of Allenwood Celtic AFC in the interest of visual amenity.

Coarse fishing can be undertaken at both Ballynafagh Lake, near Prosperous and the Grand Canal.

15.2.4 Likely Future Receiving Environment / Do Nothing Scenario

In the context of this EIAR, the 'Do Nothing Scenario' represents the ongoing operation of the existing facility in accordance with the current IED Licence.

15.2.5 Potential Effects

15.2.5.1 Land Use

The operation of the existing facility has resulted in an alteration to that part of the historical land use within the overall Bord na Móna landholding. The current land use comprises mainly the landfilling of waste materials in an engineered landfill and the composting of suitable organic waste. These waste activities are permitted by the EPA in accordance with IED Licence Reg. No. W0201-03 and in accordance with the relevant planning consents as outlined in Chapter 2 (Planning and Policy). The continued operation of the existing facility will be within the site boundary lands which have already been developed. The ongoing and current waste activities will not require the change of use of any further areas of land within the overall Bord na Móna landholding.

15.2.5.2 Population

The existing landfill and composting activities are located within a large Bord na Móna landholding and are not in close proximity to dwellings. The existing facility utilises a 4.8 km long access road from the existing R403 public road, thus ensuring that waste activities are carried out at significant distances from the public.

The existing facility is not considered to have any significant negative effects on the local or broader population numbers. There is a positive effect on the local population as some of those employed at the existing facility reside locally.

Air emissions from the existing facility are in compliance with the existing IED Licence as reported in the 2017 AER, with the exception of one elevated dust deposition reading in September 2017, and are not causing a nuisance at sensitive receptors. Specific odour mitigation measures are implemented to minimise the potential impact of odour emissions from the facility. Further details are presented in Chapter 11 (Air Quality).

There is not considered to be any disruption to the social travel patterns of those residing adjacent to the existing permitted facility.

Waste accepted for landfilling at the existing facility is required to be pre-treated which minimises the organic content of the material and removes unsuitable items from the incoming waste stream.

The biological treatment process in the composting facility (which is carried out in a controlled environment) ensures that BMW is biostabilised, thereby minimising its potential to generate methane (a harmful greenhouse gas) and leachate.

Any potential effects in relation to Noise (Chapter 12), Air (Chapter 11), Water quality (Chapter 6 and Chapter 7), Material Assets (Roads and Traffic) (Chapter 10) and Landscape and Visual (Chapter 8) are dealt with in the relevant chapters of this EIAR.

15.2.5.3 Employment

The existing permitted facility provides a number of jobs in the area with the resultant off shoot benefits. The existing facility provides full time employment for 15 No. people, which includes management and administrative staff, laboratory technicians, weighbridge operator, maintenance staff, electricians, shift supervisors, technicians, drivers, operatives and cleaning staff.

Development construction works at the existing facility employs approximately 20 No. additional staff in landfill cell construction and ancillary works. The potential future development of the consented MBT facility and proposed future development works at the facility will create further construction and full-time employment opportunities.

15.2.5.4 Tourism and Amenities

Tourist amenities and activities are located at such a distance from the existing facility that they are not impacted. In addition, traffic generated by the facility does not adversely affect visitors travelling to any of these attractions. Any potential visual effects are dealt with in Chapter 8 (Landscape and Visual) of this EIAR.

Within the general area of the existing facility, there are golf courses at Knockanally (near Donadea) approximately 8 km to the north-east and Ballygibbon East and Kilshawanny Lower (near Carbury) approximately 10 km west of the site. Allenwood Celtic AFC's pitch is located to the south of the existing site entrance on the R403 at Killinagh Upper.

Ballynafagh Lake (approximately 6.5 km to the east), near Prosperous, is available for coarse fishing as is the Grand Canal, while Ardkill Bog/Ardkill Farm offers visitors a chance to see a raised bog in a controlled setting. Heather Lodge B&B, one of the few B&B's in this general area, is close to Allenwood AFC's pitch. There is also a walk at Donadea Demense (approximately 8 km to the north-east), which has a lake that is home to a variety of wildfowl. Again, all are at a considerable distance from the existing facility.

The Kildare CDP 2017-2023 aims to protect the *"architectural heritage and to encourage sensitive sustainable development so as to ensure its survival and maintenance for future generations"* (Section 12.1). This includes Carbury Castle, Newbury Hall and Demense that has Trinity Well located therein, and Ardkill House. Coolcarrigan House, which is also listed, has extensive gardens and a 19th century Hiberno-Romanesque church that is also formally preserved, both of which are open to visitors.

These tourist attractions are located a significant distance from the existing facility are not impacted. In addition, traffic generated by the existing permitted facility does not adversely affect visitors travelling to any of these attractions.

The only buildings located within the Bord na Móna landownership boundary are the constructed buildings associated with the existing facility operations. There are no listed or other buildings of significant architectural or cultural heritage within the vicinity of the existing facility.

The nearest such building is Coolcarrigan House, which is located approximately 2 km from the nearest element of the existing landfill infrastructure and is screened from the facility by an extensive coniferous forestry plantation to the west of the house.

There is no visual effect on any of the surrounding items or facilities of tourist potential. The amenity and tourist potential thereafter, especially of the waterways, would only be compromised if those seeking to travel to such might consider the effect of the traffic movements along the surrounding regional routes, as an intrusion. The Grand Canal is at such a distance from the existing permitted facility, that along with the existing and proposed vegetation cover, views from the Grand Canal of the existing permitted facility are non-existent.

Allenwood Celtic AFC's football pitch is located to the south of the existing entrance on the R403 at Killinagh Upper and is regularly in use by the club. There are no proposed works to make any amendments to the existing entrance and therefore there are no new potential effects on this amenity. A wide belt of mixed deciduous and evergreen trees and shrubs has been planted by the developer along the entire boundary of the Bord na Móna landholding with the grounds of Allenwood Celtic AFC in the interest of visual amenity.

15.2.6 Community Gain

The existing WMF has been designed, constructed and is operated to Best Available Techniques (BAT) and in full accordance with the existing IED Licence for the facility. All information on the facility is available to interested parties in accordance to Condition 2.2.2.7 of the current IED License and a complaints register is maintained at the facility in accordance with Condition 11.4. The EPA undertake regular site visits to the facility, the latest of which was in November 2017, which record IED Licence compliance.

Community Liaison Committee

A community liaison committee has been established under the auspices of Kildare County Council in respect of the existing Drehid WMF. The committee comprises eight members, as follows:

- two local community representatives;
- two additional representatives: one from the Maynooth municipal district and one from the Kildare – Newbridge municipal district;
- two personnel from Bord na Móna; and
- two personnel from the Planning Authority (Kildare County Council).

Drehid WMF Community Development Fund

Bord na Móna has established a Community Development Fund with Kildare County Council in respect of the existing facility in accordance with Condition No. 17 of PL09.212059. This fund contributes to the provision of environmental improvement and recreational or community amenities in the locality. The identification of such projects is decided by the Planning Authority in consultation with the Community Liaison Committee. As reported in the 2017 AER, a contribution of €380,570 has been made to the community fund for 2017.

Public Education

The educational room in the Administration Building is used for the provision of a public education area for environmental education needs. Poster presentations and literature on waste management and on the workings of the existing facility are are available in this meeting room. Provision is also made for the inspection of the facility IED Licence and Annual Environmental Reports (AERs) in this room.

15.2.7 Health and Safety

TOBIN Consulting Engineers have complied with the obligations as set out in the Safety, Health, and Welfare at Work Construction Regulations 2013. Principles of prevention have been considered and design risk assessments for any infrastructure or engineering works are carried out as required. As part of this process, hazards are identified and, where possible, they are engineered out. Where this is not possible, mitigation measures are included. A record is kept of any residual risks arising and these are passed on to the contractor in the preliminary health and safety plan.

15.2.8 Mitigation Measures

The existing facility was developed in a manner such that the effect on human beings was minimised. The existing facility generates employment in the locality. This effect is positive effect and therefore no mitigation measures are proposed in relation to employment. Employment at the existing facility has the potential to encourage persons to move to the locality or to continue to reside in the local area rather than moving to urban areas or emigrating. Again, this is a positive effect for which no mitigation measures are required. There are no potential negative effects on tourism and amenities in the area and therefore no mitigation measures are required.

The following measures ensure that the existing permitted facility's effect on the receiving environment is minimised:

- Dust, air, odour, noise and surface/ground water are monitored on site in compliance with the requirements of the facility IED Licence;
- Mitigation measures in relation to the visual effects are discussed in Chapter 8 (Landscape and Visual); and
- The Community Development Fund that has been put in place provides benefits for the local community through the provision of environmental improvement and recreational or community amenities in the locality.

Specific mitigation measures for Landscape & Visual (Chapter 8), Noise & Vibration (Chapter 12), Water Quality (Chapter 6 and Chapter 7), Material Assets (Roads and Traffic) (Chapter 10) and Air Quality (Chapter 11) are dealt with in the respective chapters in this EIAR.

15.3 HUMAN HEALTH

15.3.1 Introduction

A human health risk assessment is the process to estimate the nature and probability of adverse health effects in humans as a result of the existing facility.

The assessment has had regard to the findings of other Chapters of this EIAR and, in particular, to:

- Chapter 7: Water;
- Chapter 11: Air Quality;
- Chapter 12: Noise and Vibration; and
- Chapter 14: Climate.

Drehid is an existing long-established waste facility operated by Bord Na Móna. A description of the baseline local population, including its demographics, is provided in Section 15.2.2 of this Chapter. The development site is located within a large Bord na Móna landholding and the existing waste infrastructure is not in close proximity to dwellings. The existing facility utilises existing internal road infrastructure and access so impacts on the local population are minimised.

This assessment is focused on potential human health effects related to emissions, during the operational phase as well as during ongoing construction activities associated with the operational activities (i.e. construction of landfill capacity). It is acknowledged that people may experience annoyance or other disturbance from temporary effects of the construction phase. Annoyance or other similar disturbance is not in itself a health effect, and it is also noted that the existing facility in currently active with long-established operations. Residents are accustomed to living in the environment of a landfill and the ongoing and future activities of the existing facility will not vary significantly from current activities during

the operational phase. It is unlikely that annoyance on a temporary basis that might occur during construction could lead to adverse health effects.

15.3.2 Methodology

This assessment has been prepared in accordance with the relevant guidelines produced by the EPA. Data has been collected primarily through a review of relevant documents listed below and information gathered through the extensive public consultation (associated with proposed development works at the facility as described in Chapter 1 (Introduction)) and mapping provided by the design team. A literature review on the potential impacts of landfills on human health has also been carried out and is detailed below.

Aspects examined in this chapter primarily relate to impacts from the existing facility on socio-economic activities and on local community health. These two themes are discussed together in some sections of this chapter but separately in other sections where appropriate.

15.3.2.1 Relevant Guidelines, Data Sources and Consultations

This assessment has been prepared having regard to the following guidelines:

- Guidelines on the Information to be contained in Environmental Impact Statements (EPA, 2002);
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA, 2003);
- Advice Notes for Preparing Environmental Impact Statements (Draft) (EPA, September 2015);
- Revised Guidelines on the Information to be Contained in Environmental Impact Statements (Draft) (EPA, September 2015);
- Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (Draft) (EPA, August 2017);
- Guidelines for treatment of tourism in an Environmental Impact Statement (Fáilte Ireland, 2011);
- European Commission Guidance (2003) Implementation of Directive 2001/42 on the assessment of the effects of certain plans and programmes on the environment;
- The World Health Organisation (WHO) Night time Noise Guidelines for Europe;
- Health Impact Assessment Resource and Tool Compilation (US EPA, 2016);
- WHO Guidelines for Community Noise (1999);
- Health in Environmental Impact Assessment - A Primer for a Proportionate Approach (IEMA, 2017); and
- Health Impact Assessment (Institute of Public Health Ireland 2009).

15.3.2.2 Data Sources and Consultations

An assessment of the potential impacts on human beings, population and human health requires an understanding of the community which is built up through background research, site visits and discussions with members of the local community and the findings of the assessment of the

environmental factors (pathways) through which health could be affected such as air, noise, water, soils, property acquisition or demolition and traffic volumes. The potential impacts of the existing facility on human beings, population and human health is then assessed against this background data.

Background data has been collected for the existing facility development by means of:

- Primary data sources (e.g. demographic data from Census 2016, Census 2011 and Census 2006 as produced by the CSO);
- Maps of the surrounding area, including Ordnance Survey 1:50,000 maps and aerial mapping;
- Public consultation process which included discussions with local organisations and residents and with relevant statutory bodies (carried out as part of proposed future development works at the facility as described in Chapter 1 (Introduction) and detailed further in the Proposed Development EIAR);
- A literature review on the potential impacts of landfills on human health. This review has focused on reviewing scientific evidence of the potential impacts on human health and is detailed in the relevant sections below; and
- Collating the results of the assessment of the environmental factors (pathways) through which health could be affected such as air, noise, water, soils and traffic volumes, which are based upon reference to accepted standards/guidelines/limits for the protection of human health.

In this Chapter, as assessment is performed by considering health in its broader aspects. As well as considering the protection of health, this chapter also considers opportunities for health improvements and access to services. The data used to assess opportunities for health improvements and access to services including information gathering during the public consultations.

15.3.2.3 Impact Assessment Methodology – Human Health

This section sets out the methodology that was used in order to assess the impact of the existing facility on health.

The recitals to the 1985 and 2011 EIA Directives refer to “Human Health” and include “Human Beings” as the corresponding environmental factor. The 2014 EIA Directive (2014/52/EU) changes this factor to “Population and Human Health”. However, no specific guidance on the meaning of the term Human Health has been issued in the context of Directive 2014/52/EU. In addition, no specific guidance on the assessment of human health in the context of EIA has been issued to date.

The 2017 draft EPA *Guidelines on the Information to be contained in Environmental Impact Assessment Reports* note that *“while no specific guidance on the meaning of the term Human Health has been issued in the context of Directive 2014/52/EU, the same term was used in the SEA Directive (2001/42/EC)”*. The Commission’s Strategic Environmental Assessment (SEA) Implementation Guidance (Section 5.26) states that *“The notion of human health should be considered in the context of the other issues mentioned in paragraph (f) and thus environmentally related health issues such as exposure to traffic noise or air*

pollutants are obvious aspects to study". (Paragraph (f) (of Annex I of the SEA Directive) lists the environmental factors including soils, water, landscape, air etc.).

The 2017 draft EPA Guidelines note that the above health assessment approach is consistent with the approach set out in the 2002 EPA Guidelines where health was considered through assessment of the environmental pathways through which it could be affected, such as air, water or soil, viz – *"The evaluation of effects on these pathways is carried out by reference to accepted standards (usually international) of safety in dose, exposure or risk. These standards are in turn based upon medical and scientific investigation of the direct effects on health of the individual substance, effect or risk. This practice of reliance upon limits, doses and thresholds for environmental pathways, such as air, water or soil, provides robust and reliable health protectors [protection criteria] for analysis relating to the environment"*.

The 2017 draft EPA guidelines also note that in an EIAR, *"the assessment of impacts on population & human health should refer to the assessments of those factors under which human health effects might occur, as addressed elsewhere in the EIAR e.g. under the environmental factors of air, water, soil etc."* and that *"Assessment of other health & safety issues are carried out under other EU Directives, as relevant. These may include reports prepared under the Integrated Pollution Prevention and Control, Industrial Emissions, Waste Framework, Landfill, Strategic Environmental Assessment, Seveso III, Floods or Nuclear Safety Directives. In keeping with the requirement of the amended Directive, an EIAR should take account of the results of such assessments without duplicating them"*.

The Institute of Environmental Management and Assessment (IEMA) in the UK issued a discussion document in 2017 *Health in Environmental Impact Assessment - A Primer for a Proportionate Approach*, which it describes as a primer for discussion on what a proportionate assessment of the impacts on health should be in EIA and is a useful document when considering what can and should be assessed in the context of EIA. Regard has been had to the general approach advocated in this document when compiling this Chapter.

One of the messages in the IEMA document in terms of assessing health in EIA, is that there should be a greater emphasis on health outcomes, (that is the potential effects on human health), rather than simply the health determinants, (that is the agents or emissions which could have the potential to have health effects). The IEMA document noted that in EIA, there has previously been a strong focus on just the agents or emission levels (e.g. dust) rather than focussing on the effects of these agents/emission levels on human health. This change in emphasis does not mean a complete change in practice. For example, measurement and modelling of dust levels continues to be an essential part of the health assessment.

The IEMA document notes that *"public health is defined as the science and art of promoting and protecting health and well-being, preventing ill-health and prolonging life through the organised efforts of society and has three domains of practice: health protection, health improvement and improving services"*. The IEMA document suggests that these three domains should be considered in the

assessment of health in EIA. Examples of health protection issues to be considered could include issues such as chemicals, radiation, health hazards, emergency response and infectious diseases whilst health improvement issues could include lifestyles, inequalities, housing, community and employment. Examples of improving services issues could include service planning, equity and efficiencies.

The World Health Organization (WHO) defined health in its broader sense in its 1948 constitution as *"a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity"*. Therefore, whilst the EPA guidance is useful in terms of health protection, for a more holistic assessment as per the IEMA document, it is also worthwhile to look at broader health effects in terms of opportunities for improvement of health and for improvement of access to services. While it is important to do this, it is also important not to attribute every conceivable event as being a health effect. To further rely on the WHO definition, a health effect would be something that would have a material impact on somebody's physical mental and social well-being be that positive or negative.

Therefore, health protection, health improvement and improving services are all considered in this Chapter. The methodology for assessing health protection is considered further below.

15.3.2.4 Health Impact Assessment and Environmental Impact Assessment

The IEMA document notes that Health Impact Assessment (HIA) and EIA are separate processes and that whilst a HIA can inform EIA practice in relation to human health, a HIA alone will not necessarily meet the EIA human health requirement. HIA is not routinely carried out for major infrastructure schemes in Ireland.

Guidance for performing HIA's was issued by the Institute of Public Health in Ireland in 2009. There are, however, considerable difficulties in performing a HIA as outlined by the Institute of Public Health for a project such as this. Not least of these is the difficulty of getting baseline health data. It is quite difficult due to patient confidentiality and other reasons to accurately determine levels of even relatively common medical conditions in a relatively defined population that might be affected by a waste/landfill facility. Qualitative and quantitative baseline health data is a vitally important part of the appraisal section of the HIA. In the absence of an accurate baseline, it is very difficult to assess qualitative and quantitative changes that might occur. One could use more generalised data that might exist for larger areas such as a city or county but these would be, at most, an estimate of the local baseline and not accurate enough to allow for meaningful interpretation.

The IEMA document notes that the WHO provides an overview of health in different types of impact assessment[46] and presents the WHO perspective on the relationship of HIA to other types of impact assessment as follows:

[46] World Health Organization Regional Office for Europe. Health in impact assessments: opportunities not to be missed. (2014)

"The health sector, by crafting and promoting HIA, can be regarded as contributing to fragmentation among impact assessments. Given the value of impact assessments from a societal perspective, this is a risk not to be taken lightly ... The need … and justification for separate HIA cannot automatically be derived from the universally accepted significance of health; rather, it should be demonstrated whether and how HIA offers a comparative advantage in terms of societal benefits …

Health issues can, and need to, be included [in impact assessment] irrespective of levels of integration. At the same time, from a civic society perspective, it would be unacceptable for HIA to weaken other impact assessments. A prudent attitude suggests optimizing the coverage of health along all three avenues:

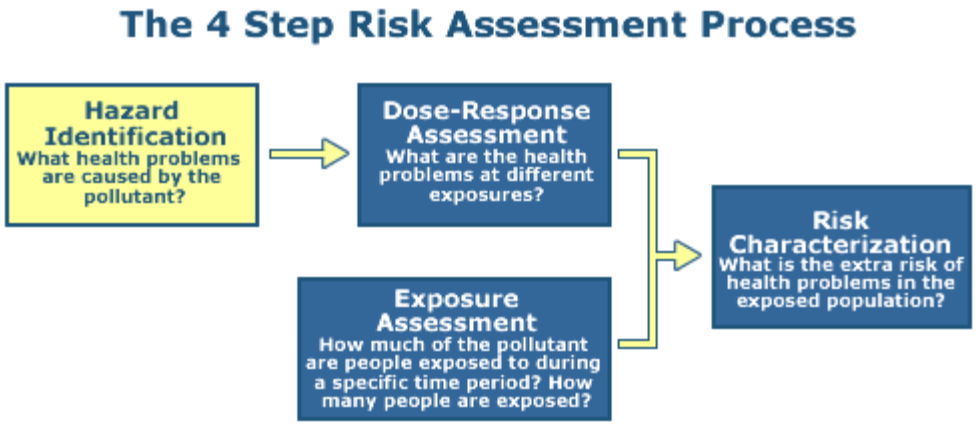
- *better consideration of health in existing impact assessments other than HIA;*
- *dedicated HIA; and*
- *integrated forms of impact assessment."*

It is clear, therefore, that even the WHO does not support a stand-alone HIA unless it could be demonstrated to be of advantage over the EIAR. It is for these reasons that this health assessment is part of the EIAR and there is no stand-alone HIA.

It is, therefore, important to note that this assessment on human health is part of an overall EIAR rather than a stand-alone HIA. The HIA is defined as a combination of procedures, methods and tools that systematically judges the potential, and sometimes unintended, effects of a policy, plan, programme or project on both the health of a population and the distribution of those effects within the population, whilst the health assessment in the context of EIA focuses the attention of the assessment on likely significant effects, i.e. on effects that are deemed likely to occur and, if they were to occur, would be expected to be significant (as per the requirements of the EIA Directive). Conducting a HIA will not necessarily meet the EIA population and human health requirement.

15.3.2.5 Health Protection

The assessment of human health for the existing facility, in terms of health protection, follows the approach set out in the EPA guidelines and in the Commissions SEA Implementation Guidance. It is also similar in nature to the US EPA guidance. Human Health protection is considered through the assessment of the environmental factors (pathways) through which health could be affected such as air, noise, water and soils. The US EPA guidance includes a four-step approach which is represented graphically below.



The potential noise, air, soils and water impacts which could affect human health were identified (Hazard Identification), the scale of these potential impacts (Dose-Response Assessment) and their duration (Exposure Assessment) were assessed and the significance of the potential impact on human health determined (Risk Characterisation).

When using a recognised Health Based Standard, the dose-response assessment is actually included in the standard. In other words, the authorities or expert committees which recommended the level of the standard will have taken into account the health problems at the different exposure levels and set the level within the standard to prevent these problems from occurring.

15.3.2.6 Health Improvement

Projects that have the potential to support regeneration, reduce unemployment and improve socio-economic circumstance, could contribute to improving the health and wellbeing of socio-economically deprived communities.

Every human activity generates or has the potential to generate waste. The efficient and safe disposal of that waste is a prerequisite for the activity. The absence of appropriate waste handling facilities would impact on the socio-economics of the community.

15.3.2.7 Identification of vulnerable groups

While every human being should be considered a sensitive receptor, the vulnerable are the most sensitive. These vulnerable groups may be more susceptible to impacts associated with the existing facility.

Children and adolescents constitute a vulnerable group partly due to their need to be able to move around freely to and from school and recreational activities. They lack the experience and judgement displayed by adults when moving around traffic in public spaces. Studies[47] show that they may also be more sensitive than adults to air pollution and other environmental factors.

[47] http://www.who.int/ceh/risks/en/

Elderly people constitute a very variable group when it comes to their need and scope for moving around the community. Generally speaking, the elderly people are slower in their movements and more health conditions may occur. Elderly people in general have greater sensitivity to air pollution and potential effects on the respiratory system and cardiovascular system and more likely to express anxieties in relation to potential air quality or noise impacts due to the existing facility. There are many reasons for this sensitivity, including the possible presence of other medical condition such as respiratory or cardiovascular disease. Subtle changes in the environment have the potential to have an adverse effect that would not be experienced by younger more resilient persons. There are other vulnerable groups also, for example, persons with disabilities or persons with mental illness. It is important to note that, in this assessment, it is assumed that all areas contain highly vulnerable individuals including the old, the very young, disabled and persons with disabilities, as well as people who are sick today or who may be sick during the operational lifetime of the facility. Vulnerable groups of people occur throughout the receiving environment for the existing facility and include, among others, a crèche, schools, nursing home and areas with a higher number of older family groups.

15.3.2.8 Community Profile County Kildare

The Drehid WMF is situated in County Kildare. Evidence shows that different communities have varying susceptibilities to health impacts both positive and negative as a result of social and demographic structure, behaviour and relative economic circumstance.

Whilst specific health data for individuals in the vicinity of the existing facility is confidential and difficult to establish, a community profile has been used to establish the baseline and identify unequal distributions in existing factors such as deprivation or burden of poor health, in order that changes in community exposure to certain health pathways and their degree of impact on the population or community can be assessed.

A group made up of the Health Service Executive (HSE), Lenus and the Irish Health Repository have published health profiles for all the Local Authorities areas in Ireland and a health profile is available for County Kildare. The most recent profiles published relate to 2015 and have been used to establish a community health profile in the vicinity of the existing facility:

- County Kildare is the fifth most affluent Local Authority nationally;
- County Kildare has a low dependency ratio of 48.0% (i.e. the number of persons aged 0-14 and 65 and over as a proportion of those aged 15-64). The national rate 49.3%;
- County Kildare has an above average birth rate of 17.5 (national 15.8);
- Male incidence rate of malignant colorectal cancer is the highest nationally, and male and female incidence rates of malignant melanoma are above the national rate; and
- Rates of mortality for all causes and the major causes of mortality for all ages are either average or below the national average.

In terms of deprivation, the health profile report includes a map (see Figure 15.2) which shows deprivation levels as a percentage of population compared to national levels. It is important to note that while the data is taken directly from the HSE document it reflects relatively large areas and does not reflect what is happening on a smaller more local scale. In other words, areas which are categorised as affluent will contain small areas which are disadvantaged and similarly areas shown as disadvantage will contain individuals or groups of considerable advantage. This shows geographically that County Kildare has relatively large areas which are marginally above average in terms of affluence or marginally below average. From the map, it can be seen that Carbury is in an area which is marginally below average affluence but adjacent to an area which is marginally above average affluence. Clearly the area is neither very affluent or very disadvantaged.

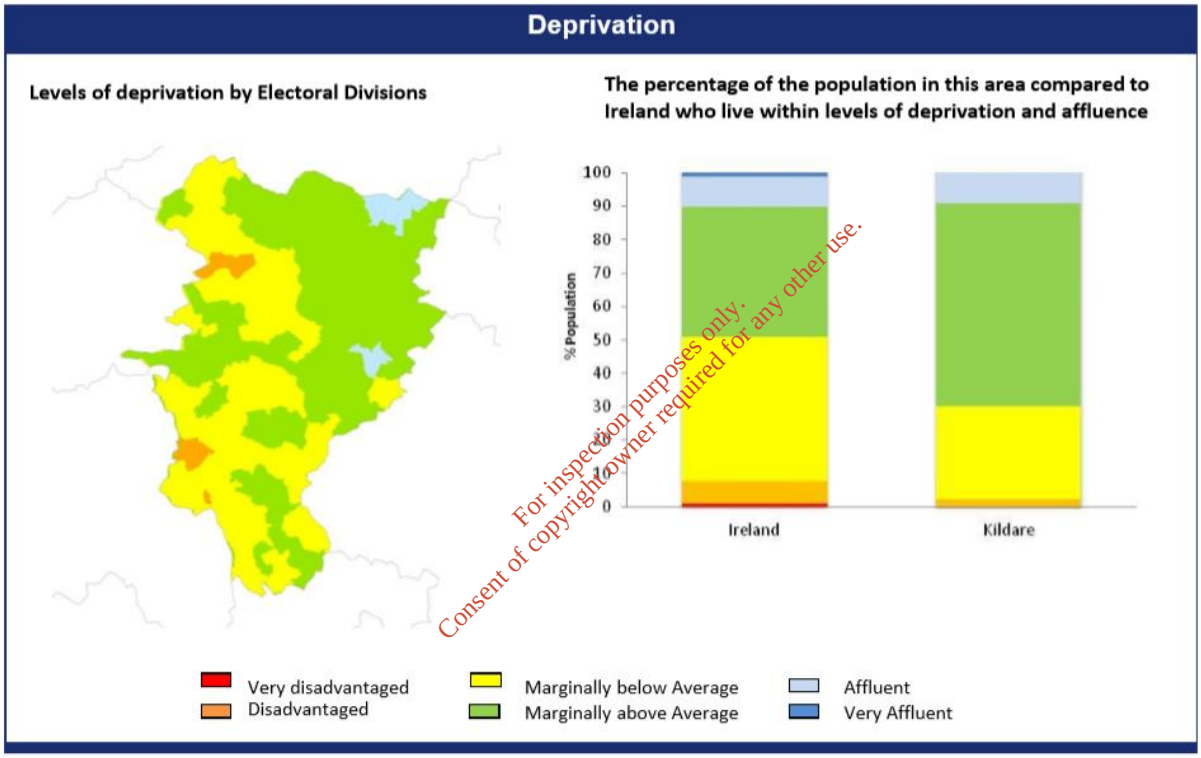


Figure 15.2: Deprivation Levels in County Kildare

15.3.3 Receiving Environment

The overall Bord na Móna landholding is located within the Timahoe Bog in Allenwood, County Kildare. Within the landholding, Bord na Móna operates the licensed Drehid WMF, accessed from the regional R403 road, at Killinagh Upper, by a 4.8 km long internal access road, which is dedicated to the existing facility.

The existing facility is licensed by the EPA through an IED Licence (Reg. No. W0201-03). The existing facility compromises an engineered landfill, composting facility and associated infrastructure including administration buildings, gas utilisation plant, settlement lagoons, leachate management infrastructure, weighbridge and access roads. The hours of operation of the existing facility are limited to operation between the hours of 08:00 and 19:00 Monday to Saturday. The waste acceptance hours are between

08:00 and 18:30 Monday to Saturday. An MBT facility situated to the south of the existing landfill infrastructure, which has received planning permission and is licensed by the EPA (Reg. No. W0283-01), is not yet constructed.

The surrounding environment is rural in nature with residential properties located around all boundaries at varying distances from the landholding boundary. The red line boundary of the existing facility as shown in Figure 1.1 is positioned within the central part of the landholding and, hence, is significantly set back from sensitive properties.

The nearest sensitive receptor is c. 970 m to the north-east from the nearest element of the existing landfill infrastructure and c. 1,280 m to the south-west from the existing composting facility.

15.3.3.1 Characteristics of the Development

What is of potential relevance to human health are emissions to air, including Particulate Matter (PM) such as PM_{10} and $PM_{2.5}$ as well as other potential air pollutants such as NO_2, SO_2 and dioxins etc. and, therefore, these are assessed under Dose-Response. Other aspects of relevance include potential emissions to water / groundwater and noise.

15.3.4 Literature Review

The term 'landfill' is extremely broad and complex with the potential for a wide variety of exposures and exposure scenarios involving a multiplicity of agents with different toxicological properties.

The site factors affecting the likelihood that a landfill leads to potentially harmful population exposure include engineering and containment, hydrogeology and topography, the type and quantity of waste contained, the mixing of contents, the presence and depth of leachate and the management practices.

The main concerns on health consequences derive from emissions of chemical mixtures or infectious agents.

Epidemiological studies on the health effects of waste landfills exist, but many share the important weakness of the lack of direct exposure measurement. For this reason, the exposure pathways are either modelled (for example using geographical information systems) or, more frequently, assessed through surrogate measures, such as the distance of the residence from the landfill sites.

It is against this background that the author reviewed the medical literature specifically in relation to the existing landfill accepting MSW material and the composting facility accepting organic waste.

The review consisted of:

- PubMed[48]: An online resource which comprises over 26 million citations for peer-reviewed biomedical literature from MEDLINE (the U.S. National Library of Medicine® (NLM)), life science

[48] https://www.ncbi.nlm.nih.gov/pubmed/

journals, and online books;

- Review of health-related literature; and
- Internet searches performed on Google.

15.3.4.1 Summary of Literature

In Ireland, a report was commissioned by the Health Research Board (HRB) at the request of the Department the Environment and Local Government. This was published in 2003 and was entitled *Health and Environmental, Effects of Landfilling and Incineration of Waste – A Literature Review*. This will be referred from here as the HRB Report.

In the UK, The University of Birmingham/Enviros study 2004 published *Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes* which also looked at this area. This report was commissioned by the Department of the Environment Food and Rural Affairs (DEFRA). This will be referred to as the DEFRA report. As the name suggests, it concentrated on municipal waste but nevertheless does contain a good review of the literature at that time covering all aspects of landfill. The UK report was well resourced and comprehensive. As stated it is largely a literature review and most had already been reported in the HRB report. It did, however, conclude though that the *"health effects of handling Municipal Solid Waste by methods including, but not exclusively landfilling had at most a minor effect on human health"*.

The author has relied on these publications and the following studies which predate their publication are taken directly from either or both documents.

Since then, there have been a number of useful reviews. The WHO published Population health and waste management: scientific data *and* policy options. Report of a WHO workshop, Rome, Italy, in March 2007.

There was also a review entitled *Systematic review of epidemiological studies on health effects associated with management of municipal solid waste* by Porta et al which was released in December 2009 by the Journal of Environmental Health 2009, 8:60. This will be referred to as the Porta review.

Finally, a review Health effects associated with the disposal of solid waste in landfills and incinerators in populations living in surrounding areas: a systematic review by Mattiello et al was published in 2011. This will be termed the Mattiello review.

Regarding composting, a review was published in 2015, Exposures and health outcomes in relation to bioaerosol emissions from composting facilities: a systematic review of occupational and community studies by Pearson et al. This concluded that whist there were some respiratory effects that these were limited to within 250 m of the actual composting site. The nearest sensitive receptor or domestic dwelling is at a distance of >1 km from the existing composting plant.

The other major disadvantage in interpreting the literature is that they are by their nature historical. Many of the studies date back some years but also many of the health conditions have a long latent period, that is the time between exposure and the development of symptoms which for some effects such as cancer may be many years. They reflect practices which bear little relationship to modern controls such as the limitations on materials entering the facility and perhaps as importantly the engineering controls in a modern engineered landfill such as the existing facility.

15.3.4.2 Important General reviews of Landfills Reviews

Redfearn and Roberts (2002) presented a detailed review of the available epidemiological literature on landfill and health. They separated the available epidemiological studies into four categories as follows:

- Single site studies of waste sites including hazardous waste sites, illegal landfills;
- Multi-site studies of sites including hazardous waste sites, illegal landfills or “inhouse” of industry;
- Single site epidemiological studies of potential health effects associated with landfill including some sites accepting hazardous waste; and
- Multi-site epidemiological studies of potential health effects associated with waste disposal sites, some accepting hazardous waste.

They discounted the first two groups of studies as concerning sites which did not in any way parallel current UK landfill practice, and which they felt were therefore not useful in interpretation of effects. The papers in the latter two categories are summarised. The DEFRA report largely used this summary in their review some two years later.

They categorised studies according to health outcome and whether the study indicated an excess risk for those residing in the vicinity of a landfill for that health outcome and those indicating no excess risk. Those reported as demonstrating excess risk showed a significant positive association between a health outcome and proximity to a landfill site. Those indicated as showing no excess risk did not show a statistically significant association, although the reason could be lack of statistical power to demonstrate such an association. The majority of the adverse health outcomes studied come under the categories of birth defects and other pregnancy outcomes, and cancers. The balance between studies with and without a positive finding appears more strongly in favour of outcomes with an excess risk in the case of birth defects as opposed to cancer. They cautioned about use of their study to infer that the adverse effects were actually caused by landfill. This is because there were other potential explanations. In epidemiological terms, they could not exclude confounding. An example of this might be simultaneous exposure to other pollutants such as those from industrial sources or for example social class difference between those who live close to landfills and those who do not. These types of confounders appear repeatedly in all studies and reviews of landfills.

World Health Organisation Report

This was quite a wide review published in 2007 about a wide range of waste management options. This gave an interesting summary of its conclusions in relation to landfilling, in particular. It said "*With regards to waste landfills, a wide variety of exposures, exposure pathways and exposure scenarios are involved, entailing a large complexity and difficulty in estimating the health risks possibly involved. Only few epidemiological studies have evaluated sites with respect to the types of chemicals they contain and release; most studies on the health effects of waste landfills in fact lack direct exposure measurement, and rely on residential distance from the site or sometimes on exposure modelling. Many health endpoints have been considered in epidemiological studies, including cancer incidence and mortality and reproductive outcomes such as birth defects and low birth weight. Despite the methodological limitations, the scientific literature on the health effects of landfills provides some indication of the association between residing near a landfill site and adverse health effects. The evidence, somewhat stronger for reproductive outcomes than for cancer, is not sufficient to establish the causality of the association. However, in consideration of the large proportion of population potentially exposed to landfills in many European countries and of the low power of the studies to find a real risk, the potential health implications cannot be dismissed".*

The report commented on another review in Italian by Linzalone and Bianchi (2005). It concluded that there were no consistent results in studies on cancer incidence, mortality and congenital malformations reported. Increases in low birth weight and different types of symptoms were consistently found. They stated that the availability of environmental data and individual measurements of exposure was very poor in most of the studies.

The WHO report also noted that concurrently with the workshop, three multi-site studies were published, two of them dealing with United States hazardous sites. In the first one (Kuehn et al., 2007), a series of significant risks for congenital malformations, decreasing with distance from the sites, have been found; in the second one (Mueller et al., 2007) foetal deaths for women residing near the sites were not associated with the distance but an association was observed among women residing less than one mile from pesticide–containing sites. The third study (Jarup et al., 2007) analysed the risk of giving birth to a child with Down Syndrome, associated with residence near 6,289 No. landfill sites (processing special, non-special and unknown waste type) in England and Wales. Postcodes within the 2 km zone were classified as exposed and people living beyond 2 km comprised the reference population. No excess risks of Down Syndrome related to landfill sites were found and adjustment for socioeconomic status did not influence the estimates.

The Russi Review 2008

This review carried out Medline searches of the peer-reviewed English language medical literature covering the period from January 1980 to June 2006 using the keywords "toxic sites" and "cancer", and identified articles from published reviews. They studied cancer incidence in communities surrounding hazardous waste landfills. As the authors recognised, some of the locations investigated included both

toxic wastes and municipal solid wastes. Most studies did not appear to be responses to a recognised cancer mortality cluster. Studies were highly variable with respect to handling of competing risk factors and multiple comparisons.

The Porta review 2009

This is noteworthy as it is recently published. It reported:

"In most cases the overall evidence was inadequate to establish a relationship between a specific waste process and health effects; the evidence from occupational studies was not sufficient to make an overall assessment. For community studies, at least for some processes, there was limited evidence of a causal relationship and a few studies were selected for a quantitative evaluation. In particular, for populations living within two kilometres of landfills there was limited evidence of congenital anomalies and low birth weight with excess risk of 2 percent and 6 percent, respectively. The excess risk tended to be higher when sites dealing with toxic wastes were considered. For populations living within three kilometres of old incinerators, there was limited evidence of an increased risk of cancer, with an estimated excess risk of 3.5 percent. The confidence in the evaluation and in the estimated excess risk tended to be higher for specific cancer forms such as non-Hodgkin's lymphoma and soft tissue sarcoma than for other cancers".

Recent Reviews

There have been some reviews published in the last few years. These, however, were largely reviews of previously published data rather than anything new.

A review of reproductive outcomes by Kihal-Talantikite et al in 2017 concluded:

"There is suggestive evidence from the post-1990 literature that residential proximity to polluted sites (including landfills*, hazardous* waste *sites and industrial* facilities*) might contribute to adverse reproductive outcomes, especially congenital malformations and low birth weight-though not mortality. This body of evidence has limitations that impede the formulation of firm conclusions, and new, well-focused studies are called for. The* review *findings suggest that continued strengthening of rules governing industrial emissions as well as industrial* waste *management and improved land use planning are needed".*

In summary any effects on health, and the predominant opinion in the literature is that there are none for modern well managed landfills, related to hazardous waste landfills. It is important to point out that the proposal is for management of Municipal Solid Waste and Composting only and that no hazardous waste will be handled.

15.3.4.3 Specific Health Effects

Congenital malformations/reproductive problems

The HRB report stated that a number of studies have shown an apparent increase in the incidence of low birth weight, birth defects. Problems were reported around some hazardous waste landfills falling significantly below current operating standards, such as Love Canal in the U.S. Again, the author would stress that these would have been 'dumps' in every sense and more or less anything could find its way in and thereafter out.

The report also said studies such as Geschwind et al. 1992, Budnick et al. (1984), Croenet al. 1997, Roberts et al. 2000 and more recently Goldberg (2005) reported similar findings but also shared common limitations. It is, however, fair to say that low birth weight is one of the most consistent findings. However, it is also one of the factors most vulnerable to confounders. For example, two factors very closely linked to low birth weight are lower social class and maternal smoking. It has been repeatedly found that deprivation scores are consistently higher around landfills.

The most quoted study in relation to hazardous waste landfills is the European study by Dolk et. al., known as the EUROHAZCON which was published in the Lancet on August 8th, 1998. This was a multi-centre case control study near hazardous waste landfill sites. This showed statistically significantly raised risks of congenital abnormalities. The author cautioned on interpretation of causal link on the basis of this data however as other confounders could explain the difference. For example, unlike the existing facility, the hazardous waste landfill sites tended to be located in the industrial, previously polluted areas and both environmental and possible other factors such as occupational exposures could explain the difference. Nevertheless, the study is useful in dealing with hazardous waste sites. However, as the proposed landfill site for a specific hazardous waste material in a modern landfill this study is of limited relevance.

Chromosomal congenital anomalies, as opposed to total anomalies, were studied in a further report from the EUROHAZCON group (Vrijheid et al. 2002). The investigators reported a higher risk of chromosomal anomalies in those who lived within 3 km of a hazardous waste site when compared to those in the study population who lived between 3 and 7 km from one of the study sites.

A Scottish study (Morris 2003) showed no statistically significant excess risks of congenital anomalies or low birth weight in populations living near special waste landfill sites in Scotland.

A Danish study (Kloppenborg 2005) found no association between waste landfill location and congenital anomalies combined or of the nervous system. However, they found small excess risk for congenital anomalies of the cardiovascular system. No causal mechanisms are available to explain these findings, but the authors offered possible alternative explanations including approximated birth rates and residual confounding.

A Welsh study (Palmer 2005) reported an apparent increase in the rate of congenital abnormalities in the vicinity of 24 No. Welsh landfills after opening from 1983 to 1997. Many of these were "Special waste", that is, hazardous sites. They concluded that a causal relationship could not be established. It is of note

that when the study looked at enhanced data from 1998 to 2000 it did not show a significant increase. In addition, the landfills studied were also examined in the earlier but much larger Elliot study. The latter is considered by many to be the most complete and these findings will be dealt with separately.

A British study (Jarup 2007) studied the risk of Down's Syndrome in the population living near 6,829 landfills in England and Wales. It studied those who lived in a 2 km zone around each site, people beyond this zone were the reference group. A 2-year lag period between potential exposure of the mother and her giving birth to a Down's Syndrome child was allowed. The analysis was adjusted for maternal age, urban-rural status and deprivation index. No statistically significant excess risk was found in the exposed populations, regardless of waste type.

Of note is a January 2004 study published in the Irish Medical Journal by Boyle et al. The occurrence of congenital anomalies in proximity to municipal landfill sites in the Eastern Region (counties Dublin, Kildare, Wicklow) was examined by small area (district electoral division), distance and clustering tendencies in relation to 83 No. landfills, five of which were major sites. For the more populous areas of the region, 50% of the population lived within 2-3 km of a landfill and within 4-5 km for more rural areas. They concluded that congenital anomalies were not found to occur more commonly in proximity to municipal landfills.

Cancers

The HRB report pointed out that Pukkala and Ponka (2001) studied the risk of cancer in people living in houses built on top of an old municipal dump in Finland. They identified a small increase in cancers on the basis of cancer incidence rates in Helsinki. The numbers studied were quite small. The incidence of cancer was also studied around Love Canal, Janerich et al. (1981) and rates were no higher than those calculated for the entire state outside of New York City. Another study by Polednak and Janerich (1989) found no association between death from lung cancer and residence in the selected census tracts around hazardous waste landfills.

Goldberg et al. (1995.) evaluated whether cancer incidence among persons who lived near the Miron Quarry was higher than expected. Some cancers appeared increased but these increases in risk were weak and for most conditions were not statistically significant. Again, the evidence was not strong or consistent enough for conclusions to be drawn.

Jarup et al. (2002) examined cancer risks in populations living within 2 km of 9,565 No. (from a total of 19,196 No.) landfill sites that were operational at some time from 1982 to 1997 in Great Britain. No excess risks of cancers of the bladder and brain, hepato-biliary cancer or leukaemia were found, after adjusting for age, sex, calendar year and deprivation. The study was very large and had high power.

The Russi review (2008) concluded:

"To date, epidemiological studies of populations living in the vicinity of a toxic waste site have not produced evidence of a quality that most epidemiologists would consider adequate to establish a causal link between toxic waste exposures and cancer risk."

It went on to state that even if these might be an effect the magnitude is too small to be measured.

Again, to summarise, the evidence linking landfill to cancer is weak, perhaps even surprisingly so because the areas studied were again hazardous sites with known problems. Certainly, it is reasonable to extrapolate that the human risks of cancer from living adjacent to a well-run landfill are absolutely minimal.

Symptoms of illness

Many studies of symptoms conducted in communities living near landfill sites rely on self-reported symptoms. In essence, no statistically significant reproducible health effect have been demonstrated.

There is also little or no evidence of an increase in psychological illness around a landfill. This is very significant. If for example "stress" related to living close to a landfill was associated with an increase in illness one would certainly expect large numbers of published studies.

Studies of landfills workers

Gelberg et al. (1997) conducted a cross-sectional study to examine acute health effects among employees working for the New York City Department of Sanitation, focusing on Fresh Kills landfill employees. Telephone interviews conducted with 238 No. on-site and 262 No. off-site male employees asked about potential exposures both at home and work, health symptoms for the previous six months and other information (social and recreational habits, socio-economic status). Landfill workers reported a significantly higher prevalence of work-related respiratory, dermatological, neurologic and hearing problems than controls. Respiratory and dermatologic symptoms were not associated with any specific occupational title or task, other than working at the landfill, and the association remained, even after controlling for smoking status.

Elliot Studies

The largest study carried out on the health effects of landfill sites was that by Elliot et. al. for the Department of Health in the UK, published in August 2001. This appeared to show small excess risk, in the region of 1% for overall congenital abnormalities, to those living within 2 km radius of a landfill site. It also showed a higher rate for those living near a "special" (hazardous) waste site although this is less relevant to this EIAR.

To put this into context, the background rate of congenital abnormalities is about 2% of all births. A 1% increase even if true would give a rate of 2.02%. In an area of low population, one might have to wait several hundred years or even more for an effect.

Interestingly, the study showed that approximately 80% of the British population live within 2 km of a landfill site, though not all are operational. Though the study is generally well designed there are a number of limitations in this study, however, some of which it shares with some of the other studies quoted. By the nature of this type of study, it studies 'the good, the bad and the ugly', that is, covering landfill sites in all states of use, age and type of landfill, hazardous or non-hazardous. It will therefore include the well designed and operated but also those which are not. It would be possible for one or two 'bad eggs' in terms of poorly managed landfill sites to skew a study particularly given the very small level of reported excess.

There are also anomalies in the data, for example when they studied landfill sites recently opened there was an excess risk of congenital abnormalities predating the opening of the landfill site suggesting demographic or other environmental factors were primarily responsible.

While the study did attempt to allow for confounders, such as deprivation etc., in effect it is impossible to allow for all possible confounders and they did not even attempt to control for some potentially relevant factors such as smoking and occupation. Therefore, while noteworthy the findings cannot be relied upon and need to be considered in the light of the other available literature.

Elliot et al. recently updated the previous study (2009) in order to evaluate whether geographical density of landfill sites was related to congenital anomalies. The analysis was restricted to 8804 No. sites operational at some time between 1982 and 1997. There were 607 No. sites handling special (hazardous) waste and 8197 No. handling non-special or unknown waste type. The exposure assessment took into account the overlap of the 2 km buffers around each site, to define an index of exposure with four levels of increasing landfill density. Several anomalies (hypospadias and epispadias, cardiovascular defects, neural tube defects and abdominal wall defects) were evaluated. The analysis was carried out separately for special and non-special waste sites and was adjusted for deprivation, presence or absence of a local congenital anomalies register and maternal age. The study found a weak association between intensity of hazardous sites and some congenital anomalies (all, cardiovascular, hypospadia and epispadias).

15.3.4.4 Summary of Literature on Health Effects of Landfilling

One of the main difficulties about reviews of epidemiological evidence is that they are by their nature they are historical. While they may accurately reflect the situation as it was, far greater controls and engineering controls and much higher level of supervision of what enters landfills and management of potential emissions, it is certain that potential health effects are less than in the past. In other words, we can look at a worst-case scenario, but modern landfills are far better designed than what was there in the past.

At present, there is little or no evidence to demonstrate a link between cancer and exposure to landfill.

A few studies have reported putative links between hazardous landfill sites and congenital abnormalities but again these studies are somewhat inconsistent. The association between adverse birth outcomes

such as low birth weight and birth defects is somewhat stronger but may reflect socioeconomic factors rather than any exposure. Further studies are required. However, even now we can conclude if any effect is shown it will be at a very low level indeed. Again, this is of very limited relevance for this project as it does not include any hazardous materials. This and other references related to hazardous landfills are only included here for the sake of comprehensiveness.

Reports of increased risk of respiratory, skin and gastrointestinal illnesses are based mainly on self-reported symptoms. Although this evidence must not be dismissed, consideration should be given to the strong possibility of bias and the influence of fears and worry related to the waste.

It is very important to emphasise for this project, that for non-hazardous landfills, which is what is relevant for this EIAR, the evidence is strong that well managed landfills are not associated with adverse effects.

15.3.5 Dose Response Principal

In simple terms, the concept of dose response suggests that the greater the dose to which an individual is exposed, the greater either the likelihood of a health response and/or the greater the severity of that response. Inbuilt to this concept is the principle of a threshold. The threshold is the level of an agent below which one would expect no adverse response. This is a concept on which many health-based standards are based.

To illustrate this concept, we can look at an air pollutant such as nitrogen dioxide or NO_2. As levels increase from zero but remained below the threshold which is the Air Quality Standard, there is still no significant health effects. If, however the levels continue to increase above the threshold there are an increasing number of people affected and the severity of that effect also increases. Just above the threshold, only the vulnerable are likely to notice anything but as the levels increase more and more people notice an effect and indeed the severity of this effect becomes greater as levels continue to increase. This is the principle of dose response.

15.3.6 Exposure Assessment

Health-based standards therefore rely on the dose response concept and try to identify by scientific means the threshold below which no significant health effects would occur. When standards are scientifically set by reliable and recognised or statutory agencies, they are a useful method in assessing the impact of any proposed change.

Health standards are set based on the threshold to protect the robust, who may be more resilient but are primarily there to protect the vulnerable. They are to protect the elderly, the very young, and the ill and by extension thereby, the robust are not affected.

An example of such health standard are the EU Air Quality Standards. These are explained by the Irish EPA[49] as follows:

"In order to protect our health, vegetation and ecosystems, EU directives set down air quality standards in Ireland and the other member states for a wide variety of pollutants. These rules include how we should monitor, assess and manage ambient air quality.

The European Commission set down the principles to this approach in 1996 with its Air Quality Framework Directive. Four "daughter" directives lay down limits for specific pollutants:

- *1st Daughter Directive: Sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead;*
- *2nd Daughter Directive: Carbon monoxide and benzene;*
- *3rd Daughter Directive: Ozone; and*
- *4th Daughter Directive: Polyaromatic hydrocarbons, arsenic, nickel, cadmium and mercury in ambient air."*

With regards to particulate matter (PM), for example, the standards relate to relatively smaller particles that is, for example PM_{10}, which is particulate matter with a diameter of less than 10µm. The reason for this is that this size of dust can be inhaled into the lungs and travel all the way to the alveoli, for which we use the term respirable. Larger particles which are greater than 10µm but less than 30µm are potentially inhaled, that is enter the nose or mouth but do not enter the alveoli and are not respired. These are usually swallowed and do not have effects on the respiratory system.

Dust particles which are greater than 30µm are not inhalable so do not have an effect on human health and typically fall to the ground. The smaller particles can remain airborne. This is why dust on cars does not correlate with a health risk. It is only if the smaller particles are increased that human health issues may arise. In human health, it is the dust which cannot be seen that has potential for health effects, while visible dust, while being a nuisance, and may require more frequent car washing, does not affect human health. Therefore, when we are assessing the impact of practical matter on health it is PM_{10} and smaller that is relevant.

15.3.7 Risk Characterisation

In the field of risk assessment, characterising the nature and magnitude of human health or environmental risks is arguably the most important step in the analytical process. In this step, data on the dose-response relationship of an agent are integrated with estimates of the degree of exposure in a population to characterise the likelihood and severity of risk. It can be assumed that provided the predicted air emissions do not result in an exceedance of the health-based standards that there will be no significant risk.

[49] http://www.epa.ie/air/quality/standards/

15.3.7.1 Assessment of Effects of Existing Facility from Emissions to Air

A detailed air quality assessment is provided in Chapter 11 (Air Quality). The standards used in the air quality assessment include the Air Quality Standards Regulations 2011 (incorporating European Commission Directive 2008/50/EC) which has set limit values for the pollutants SO_2, NO_2, PM_{10}, benzene and CO. The Council Directive 2008/50/EC combines the previous Air Quality Framework Directive (96/62/EC) and its subsequent daughter directives (including 1999/30/EC and 2000/69/EC). Provisions were also made for the inclusion of new ambient limit values relating to $PM_{2.5}$. These are appropriate and robust standards. The air quality assessment provides detailed information on the existing emission sources and the use of AERMOD modelling.

Odour, air quality and construction dust are all separately considered. The Conclusions can be summarised as follows:

Odour

The scenarios modelled lead to odour concentrations which are in compliance with the relevant odour criterion at the worst-case receptor.

Air Quality

Regarding NO2, the modelled scenario shows ambient NO2 concentrations (including background) which are in compliance with the relevant limit values at the worst-case off-site location.

With regard to PM10/PM2.5, the ambient PM10/PM2.5 levels (including background) are in compliance with the relevant limit values at the worst-case off-site location.

Construction Dust

With the implementation of dust minimisation measures, fugitive emissions of dust from any construction works carried out at the site will be insignificant and pose no nuisance at nearby receptors.

In summary, all emissions from the existing facility are in compliance with the ambient air quality standards and will not lead to a substantive risk of non-compliance or odour nuisance.

Assessment of Effect

The human health effect for all receptors arising from ongoing and future emissions to air are assessed as being imperceptible.

15.3.7.2 Assessment of Effects of Existing Facility from Noise Emissions

By comparing the predicted noise emissions as detailed in Chapter 12 (Noise & Vibration), with reliable noise standards, it can be determined if any health effect is likely as a result.

Construction Phase

The conclusions of Chapter 12 are that, allowing for mitigation during the course of any construction works at the facility, given the distances to the nearest residences, the temporary and short-term nature

of the construction works and the calculated noise levels, the overall noise impact will occur on an occasional and short-term basis, and then only affecting the closest noise sensitive properties in the surrounding environment. The impact is determined to result in a neutral effect and will be of a short-term and negligible or at very worst slight impact at the majority of noise sensitive locations. Vibration impacts during construction works are determined to be short-term and imperceptible.

Operational Phase

The conclusions of Chapter 12 ware that measured and predicted noise levels at the nearest sensitive locations are well below the operational noise criteria in all instances. There are no vibration impacts associated with the operational phase of the existing facility.

In terms of traffic, there will be no additional traffic volumes in future years associated with the existing facility, therefore there will be an imperceptible effect from the ongoing operation of the facility in the future against the current conditions. In fact, as of January 2018, the permitted quantity of waste for acceptance at the facility has decreased from 360,000 TPA to 120,000 TPA which has resulted in a significant reduction of HGVs and cars accessing the facility as detailed in Chapter 10 (Material Assets (Roads and Traffic)). The overall traffic noise is minor to moderate, perceptible impact during peak periods.

Assessment of Effect

The human health effect for all receptors arising from noise are assessed as being Imperceptible.

15.3.7.3 Assessment of Effects of Existing Facility from Emissions to Water

The potential effects on water has been assessed in Chapters 6 (soils, Geology and Hydrogeology) and 7 (Water). These assessments concluded that due to the low magnitude of impact and low sensitivity of the surrounding environment, the residual impacts on the surrounding geological and hydrogeological regime at the site are considered to be minor and mainly long term in nature.

Assessment of Effect

Given that there is currently and will be no effect on water quality standards, the effects on human health from water are assessed as Imperceptible.

Mitigation Measures

No mitigation measures other than those detailed elsewhere in this EIAR and associated appendices are required. All control and monitoring of emissions to water are managed in accordance with the existing IED Licence for the facility.

Residual Effects

The findings of the literature review and of the detailed assessments is that the existing facility, either during construction works on the site or during operations, will not give rise to effects on human health.

Health improvements

The existing facility can be considered as potential to provide opportunities for health improvements.

Employment and income are among the most significant determinants of long-term health, influencing a range of factors including the quality of housing, education, diet, lifestyle, coping skills, access to services and social networks. Many epidemiological studies consistently show better health outcomes are associated with higher socio-economic status.

Consequently, poor economic circumstances can influence health throughout life, where communities subject to socio-economic deprivation are more likely to suffer from morbidity, injury, mental anxiety, depression and tend to suffer from higher rates of premature death than those less deprived. One of the most reliable methods to improve health within a community is to raise it socio-economic status.

Projects that have the potential to support development by providing the means to efficiently and safely deal with waste, such as the existing facility, have the potential allow for socio-economic activity that would otherwise not be possible. While the facility employs directly a relatively small number of persons, indirectly it assists in job maintenance and growth. This helps to reduce unemployment and improve socio-economic circumstance and can be considered as contributing to improving the health and wellbeing of socio-economically deprived communities.

In social health terms, economic development also brings the opportunity for reducing inequities in society. Long-term unemployment for example is detrimental to the individual, family and society. It has potential to transfer across generations so that families where the head of household is long term unemployed are themselves far more likely to become or stay unemployed. This has potential to create and sustain social inequities. The economic development opportunities provided by the existing facility and potential future site development have the potential to create more employment and reduce the risk of long-term unemployment. This in turn can lead to greater opportunities for equity in society.

15.3.8 Overall Assessment of Health Impact of the Existing Facility

Based on the assessment above, the impacts on human health are assessed as Imperceptible.

16 INTERACTIONS OF THE FOREGOING

The significant effects of the existing facility and the measures proposed to mitigate these effects have been outlined in this EIAR. However, in any development with the potential for environmental impacts, there is also the potential for interaction between effects of the different environmental aspects.

The result of these interactions may either exacerbate the magnitude of the effect or may in fact ameliorate it. As part of the requirements of an EIAR, the interaction of the effects on the surrounding environment needs to be addressed.

Table 16.1 outlines the different environmental aspects which have potential to interact as a result of the existing facility. These have been considered by the specialists when preparing this EIAR. Table 16.2 provides an explanatory note for each interaction.

It is noted that the cumulative impact assessment of the existing facility with the proposed further development of the Drehid WMF, the permitted (but not yet built) MBT facility and other relevant surrounding developments has been presented in the Proposed Development EIAR.

It is also noted that as the Drehid WMF is currently operational and the facility is operated in accordance with Best Available Techniques (BAT) and in accordance with the requirements of the IED Licence issued by the EPA, many of the interactions between environmental aspects presented in Table 16.1 and Table 16.2 do not have a significant effect as control measures are already in place to protect the environment.

Potential interactions between the effects of various environmental aspects are as follows:

- Dust suppression and vehicle wheel washes are currently utilised to mitigate the effect of windblown dust around the site and to nearby dwellings. These measures will reduce the effect on human beings and material assets in the community along with local biodiversity;
- Travel patterns will not be impacted as a result of the ongoing operation of the existing facility. Mitigation measures, which have already been employed at the site entrance, will continue to minimise the effect of the existing facility. These measures have improved road safety for all road users;
- Odours are reduced by ensuring the exposed waste face is minimised and covered on a daily basis and that the composting operation is undertaken within fully enclosed buildings;
- Professional vermin control experts are employed as necessary to ensure vermin activity is minimised. As required, an ecological expert is consulted to determine suitability and control (e.g. spread of poisons) in the context of protected species in the wider landholding. These measures will reduce effects on human beings, material assets and to local biodiversity;
- Compliance monitoring is currently undertaken (e.g. water, noise, dust etc.), as per regulatory conditions and annual environmental reports have been compiled to detail the performance of the existing facility. These reports are made available to all interested parties, which will allay public

concerns as to the operation of the site and will result in a positive interaction with respect to human beings;

- The existing facility is operated to BAT as per EPA guidance and regulation. All information is available to interested parties, a complaints register is maintained, and the EPA undertakes regular environmental audits, which demonstrate how the facility is performing. These measures result in interaction in all environmental criteria;
- It is noted that throughout this EIAR potential interaction between various environmental criteria are discussed. The existing facility is sited at a significant distance from the local road network and residential properties; and
- Avoidance of environmental effects was used throughout the design and ongoing operation of the facility. The mitigation measures proposed are designed to continue to ameliorate the effect of the existing facility on the wider environment.

While there is potential for the environmental aspects to interact and result in a cumulative effect, these assessments (as carried out herein and in the Proposed Development EIAR) have noted that potential cumulative effects do not result in significant environmental effects.

Table 16.1: Interactions between environmental aspects

Interaction Matrix	Biodiversity	Soils, Geology and Hydrogeology	Water	Landscape and Visual	Land	Material Assets (Roads & Traffic)	Air Quality	Noise and Vibration	Cultural Heritage	Climate	Population and Human Health
Biodiversity		√	√	√		√	√	√		√	
Soils, Geology and Hydrogeology			√		√				√		√
Water					√					√	√
Landscape and Visual						√		√	√		√
Land											
Material Assets (Roads & Traffic)							√	√		√	√
Air Quality										√	√
Noise and Vibration											√
Cultural Heritage											
Climate											√
Population and Human Health											

Table 16.2: Explanatory note on interactions between environmental aspects

Interaction Matrix	Biodiversity	Soils, Geology and Hydrogeology	Water	Landscape and Visual	Land	Material Assets (Roads & Traffic)	Air Quality	Noise and Vibration	Cultural Heritage	Climate	Population and Human Health
Biodiversity		Removal of peat and existing habitats.	Potential pollution of surface water. Redirecting, infilling or culverting of existing drainage channels.	Existing habitat removal / damage.		Disturbance to fauna from site traffic.	Air quality impacts on flora and fauna – dust.	Disturbance to fauna from noise and vibration generated from site activities.		Potential effects on flora and fauna from changing climate conditions.	
Soils, Geology and Hydrogeology			Potential leachate from deposited material leaching to surface water.		Changes to land use as a result of peat removal and development.				Removal of peat and potential cultural heritage.		Potential effects on drinking water.
Water					Change in runoff profile from site development.					Climate changes have the potential to increase flooding events.	Potential effects on drinking water.

Interaction Matrix	Biodiversity	Soils, Geology and Hydrogeology	Water	Landscape and Visual	Land	Material Assets (Roads & Traffic)	Air Quality	Noise and Vibration	Cultural Heritage	Climate	Population and Human Health
Landscape and Visual						Ongoing traffic movements resulting in effect on visual amenity along public road network.		Review of requirements of potential landscape mitigation measures to reduce noise effects/ or screen noise mitigation measures.	Liaison to identify cross-over's in relation to visual effects from listed monuments etc. / impact on historical landscapes.		Review of extent of visual effects experienced by local residents and potential effects on human wellbeing.
Land											
Material Assets (Roads & Traffic)							Facility traffic impact on air quality.	Traffic movements within site and along surrounding roads potential to cause noise disturbance.		Ongoing traffic impact on climate.	Potential emissions and accidents.
Air Quality										Air quality and climate effects frequently have	Ongoing landfilling activities with potential odour nuisances.

Interaction Matrix	Biodiversity	Soils, Geology and Hydrogeology	Water	Landscape and Visual	Land	Material Assets (Roads & Traffic)	Air Quality	Noise and Vibration	Cultural Heritage	Climate	Population and Human Health
										similar sources.	
Noise and Vibration											Noise emissions from the operational facility have potential to impact on human health.
Cultural Heritage											
Climate											Global health.
Population and Human Health											

17 GLOSSARY

Bio-waste

Bio-waste is defined as biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises, and comparable waste from food processing plants. (http://ec.europa.eu/environment/waste/compost/).

Composting

Composting is the biodegradation of organic matter through a self heating, solid phase, aerobic process. This converts organic matter into a stable humic substance. (http://ec.europa.eu/environment/waste/compost/pdf/econanalysis_finalreport.pdf).

Construction & Demolition Waste

Any waste generated in the activities of companies belonging to the construction sector and included in category 17 of the European List of Wastes. The category 17 provides for codes for several individual materials that can be collected separately from a construction or demolition site. It includes waste streams [hazardous and non-hazardous; inert, organic and inorganic] resulting from construction, renovation and demolition activities. C&D waste originates at sites where construction, renovation or demolition takes place. Construction waste contains several materials, often related to cut-offs or packaging waste. Demolition waste comprises all materials found in constructions. Renovation waste can contain both construction related materials and demolition-related materials. (*EU Construction & Demolition Waste Management Protocol – European Commission – September 2016*).

Leachate

Means any liquid percolating through the deposited waste and emitted from or contained within a landfill.

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