Appendix A7.1 Dispersion Modelling Assessment Methodology

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Appendix 7.1

DISPERSION MODELLING ASSESSMENT

7.1.1 Dispersion Modelling methodology

The Environmental Protection Agency Guidance Note on Dispersion Modelling (AG4) gives guidance on the use of Dispersion Models which was followed in the execution of this study. A detailed modelling assessment was undertaken using the US EPA Model AERMOD and the current regulatory version of this Model (Version 16216r). The model computes average ground-level concentrations of pollutants emitted from either elevated or ground-level emission sources. Separate utilities associated with the dispersion modelling software allow computation of ground-level concentrations of pollutants over defined statistical averaging periods, and additional features permit suitable consideration to be given to building downwash effects (downward deflection of an airstream by buildings) and the effects of elevated terrain in the vicinity of the plant.

A summary of the steps involved in the assessment is presented as follows:

(i) Characterise the receiving environment through detailed analysis of background air quality data that is representative of the area; this has been described in Section 8.3.

(ii) Determine appropriate criteria for evaluating the significance of air quality impacts through reference to Air Quality Standards and Guidelines; this has been described in Section 8.2.4.

(iii) Describe the emissions in quantitative terms and describe the Operating Conditions that will affect the emissions; this has been described in Section 8.4.1 for the Remediation Phase and Section 8.4.2 for the Operation Phase.

(iv) Predict the potential air quality impacts using a dispersion model; this has been executed as described here and the results are presented in Section 8.4.1 and Section 8.4.2.

(v) Assess the impact by comparing the calculated levels against the adopted assessment criteria.

Information on a number of input variables required for the dispersion model is described here.

(i) Emissions characteristics

Information on the physical characteristics of the emissions sources is required input data for the dispersion Model. Data on stack (or flue) dimensions and height, gas exit velocity, temperature and pollutant emission concentration are all required data for the Model. The principal assumption is that the flares will run continuously and that the emissions will be at the maximum level at all times. In practice this will not occur as the emissions will decrease over time.

A significant issue in respect of Model Input data for emissions from combustion sources is the selection of nitrogen oxides (NO_x) input data. In most combustion processes, NO_x is emitted almost totally in the form of nitric oxide (NO). NO_x are very reactive and also contribute to the phenomenon of photochemical ozone formation, due to the formation of nitrogen dioxide from nitric oxide. These transformations are generally of greatest concern in the areas where the highest ozone concentrations occur – for example, in rural areas in late afternoon in summer time.

In the EPA Modelling Guideline AG4, the recommendation for screening assessments is that a default annual NO_2 / NO_x ratio of 1.00 is used and a default hourly ratio of 0.5 is used; this is also the guidance from the UK Environment Agency "H4 Odour Management" (Environment Agency 2011) for dispersion modelling assessments. AG4 notes that the AERMOD Modelling suite treats NO_x emissions in one of two ways:

- All of the NO_x emissions are treated as NO_2 and an assumption is made that a pre-determined ratio of NO_2/NO_x applies to the predictions; this is where the default conversion rates noted above would apply; or
- The Plume Volume Molar Ratio Method (PVMRM) is used whereby an assumption is made that the in-stack NO_2/NO_x ratio is 0.1 and the equilibrium ratio is 0.90.

The EPA AG4 Guidance was published in 2010 and new Guidance has been issued by the US EPA since then and especially in 2010, 2011 and in September 2014. The most recent Guidance from 2014 is a memorandum issued on 30 September 2014 "*Clarification on the Use of AERMOD Dispersion Modeling for Demonstrating Compliance with the NO_2 National Ambient Air Quality Standard.*" This Guidance was introduced because in 2010 the US published a new 1-hour NO_2 National Ambient Air Quality Standard (NAAQS) and the Clarifications were required to explain how modelling would be executed to demonstrate compliance with the Standard. In summary, the Clarification Memos noted that the 1-hour NO_2 Standard requires different modelling considerations from the annual Standard, and that both the In Stack Ratio (ISR) of NO_2/NO_x and the ambient ozone concentration may be much more important for the 1-hour than the annual Standard. Accordingly, and in summary, the following Guidance is abstracted from the Clarification Memos:

- The most conservative approach is to assume that all of the NO_x is converted to NO_2 and this approach is generally used for screening analyses;
- When modelling to demonstrate compliance with the annual Air Quality Standard, use of an In Stack Ratio should be justified case-by-case and where source-specific data is not available, an ISR of 0.1 is recommended; for estimating impacts at distances beyond 2.5km, a conversion ratio of 0.2 is appropriate;
- When modelling to demonstrate compliance with the 1-hour Air Quality Standard, use of an ISR of 0.5 is recommended.

In this assessment, the assumption made is that all of the nitrogen oxides are present as NOx in line with current Guidance on the use of dispersion modelling for air quality impact assessment. While this may overestimate the 1-hour ground level concentration (GLC), the conservative approach does not affect the outcome of the assessment.

(ii) Site layout and topography

The layout and area of the site and the dimensions of the various plant buildings were obtained from digitized ordnance survey data and from scaled drawings. Topographical information was obtained from an aerial site survey carried out in February 2016 and from maps, orthographic photographs and digital Ordnance Survey data. Building downwash effects are unlikely as a result of the buildings on site but possible downwash effects were modelled using the modelling suite facilities.

The presence of terrain can lead to significantly higher ambient concentrations than would occur in the absence of terrain features, especially if there is a significant relative difference in elevation between the source and off-site receptors. International Guidance, and the Agency Guidance Note AG4, suggests that when modelling in a region of flat terrain, no digital mapping of terrain will be necessary. In relation to AERMOD, the guidance in AG4 is that digital mapping of terrain should be conducted where terrain features are greater than 10% of the effective stack height within 5km of the stack (for effective stack heights of 100m or less). From a review it is concluded that digital terrain data is required. This data was obtained in digital form from the site survey data and the data was processed to allow for use in the dispersion model.

(iii) Averaging intervals

The dispersion model was used to predict the incremental additions to ground level concentrations of all substances emitted from the facility over defined averaging periods. These averaging intervals were chosen to allow direct comparison of predicted ground level concentrations with the relevant assessment criteria as outlined in Section 8.2.5. In particular, 1-hour, 24-hour and annual average ground level concentrations (GLCs) of various substances were calculated at various distances from the proposed Project; percentiles of these average GLCs were also computed for comparison with the relevant Air Quality Standards.

(iv) Receptor locations

Since the impact of the emissions can be observed at considerable distances from the emission sources, a fine grid, 2km x 2km centred on the main emission sources was constructed with receptors located at 50m intervals; a second grid of 6km x 6km with receptors at 100m intervals was also constructed. In line with expectations, the highest predicted ground level concentrations occur at the receptors closer to the source. In addition to the receptor grids, a number of receptors were selected at sensitive locations in the area represented by the closest residential receptors.

(v) Meteorological data

As noted in Section 8.3.1, meteorological conditions at the proposed Project are best described by data from Casement Aerodrome. The best practice Guidance on dispersion modelling in Ireland is the publication by the Environmental Protection Agency "*Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)"* which is widely used in Ireland in Air Quality Impact Assessment studies of the type under consideration here. This Guidance Note (AG4) stipulates at Section 6.1 (Page 23) that:

> *"It is recommended that a minimum of three years of meteorological data from an appropriate meteorological station should be used in the assessment. Furthermore, the most recent year of the data set used should have been compiled within the last ten years."*

For this assessment three years of meteorological data from 2013 to 2015 for Casement Aerodrome have been used. This is expected to give a reliable assessment of the dispersion of emissions from the proposed Project.

(vi) Baseline air quality

Baseline air quality is described in Section 8.3.3 from the very comprehensive database of information available for the site as well as longer term data acquired for similar locations in Ireland.