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# Baronet Road EP Variation

Air Quality Assessment Addendum – Sensitivity Analysis

# 1 Introduction

This document is an addendum to the Air Quality Assessment (AQA) prepared by Uniper to support the application to vary the environmental permit (EP) for the Baronet Road site (ref: EPR/PP3139XA) operated by Ingevity UK Ltd. The subject of the application is to vary the permit to include for the operation of four new natural gas-fired steam boilers.

The AQA includes a number of conservative measures intended to ensure that the predicted impacts on air quality are overestimated rather than underestimated. On this basis Uniper has stated that a detailed sensitivity analysis is not required. However, the Environment Agency's (EA's) guidance on air dispersion modelling reports for environmental permitting[1] states that it is a requirement to carry out a sensitivity analysis.

For completeness, Fichtner has re-run the dispersion model with differing parameters to determine the sensitivity of the results to the choice of parameters. For all sensitivity analyses the impact of changing model parameters on the maximum annual mean and short-term concentrations of oxides of nitrogen has been considered.

# 2 Sensitivity Analysis

## 2.1 Surface roughness

The main model run used in Uniper's AQA applied a surface roughness length of 0.3 m for the dispersion site. The sensitivity of the results to using different surface roughness length has been considered by running the model with a variety of surface roughness lengths for the dispersion site.

The following parameters were kept constant:

- Stack height – 35 m
- Buildings – included;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – model default;
- Meteorological site Monin-Obukhov length – model default;
- Meteorological data used – Rostherne 2016.

[1] https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

The contribution of the new boilers to the ground level concentration of oxides of nitrogen at the point of maximum impact and at the maximum impacted human receptor is presented in Table 1.

*Table 1: Surface Roughness Sensitivity Analysis*

| Surface roughness (m) | Oxides of Nitrogen PC (µg/m³) | | |
|---|---|---|---|
| | Annual Mean | 99.79%ile of 1-hour mean | Max 1-hour mean |
| **Point of maximum impact** | | | |
| 0.1 | 0.44 | 42.28 | 56.21 |
| 0.2 | 0.44 | 42.28 | 56.21 |
| **0.3** | **0.45** | **39.81** | **56.18** |
| 0.5 | 0.47 | 35.95 | 48.60 |
| 0.7 | 0.54 | 33.41 | 39.35 |
| **Maximum impacted receptor** | | | |
| 0.1 | 0.26 | 8.91 | 12.85 |
| 0.2 | 0.26 | 8.91 | 12.85 |
| **0.3** | **0.27** | **9.27** | **12.14** |
| 0.5 | 0.28 | 9.33 | 11.26 |
| 0.7 | 0.32 | 9.07 | 10.67 |

As shown, increasing the surface roughness value leads to greater annual mean concentrations but lower short-term concentrations at the point of maximum impact. At the maximum impacted receptor the same pattern is evident, but the results are less sensitive to the choice of surface roughness length.

The value used by Uniper in the AQA of 0.3 m is recommended by the model developer CERC as the maximum appropriate for agricultural areas. This is appropriate for the dispersion site which is located between fields and open land to the north, south and west, and suburbs around 800 m to the east. Individual buildings on the Baronet Road site are included in the model so their effect does not need to be accounted for in the choice of surface roughness length.

Based on the above, the surface roughness length of 0.3 m selected for the model is appropriate, and an alternative choice within a representative range (around 0.2 m – 0.5 m) would not change the conclusions of the assessment.

## 2.2 Building parameters

The sensitivity of the results to the effect of buildings has been considered by running the model with and without the buildings presented in Table 4-2 of the AQA.

The following parameters were kept constant:

- Stack height – 35 m
- Dispersion site surface roughness – 0.3;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – model default;
- Meteorological site Monin-Obukhov length – model default;

- Meteorological data used – Rostherne 2016.

The contribution of the new boilers to the ground level concentration of oxides of nitrogen at the point of maximum impact and at the maximum impacted human receptor is presented in Table 2 for each scenario.

*Table 2: Effect of Buildings*

| Scenario used in model | Oxides of Nitrogen PC (µg/m³) | | |
|---|---|---|---|
| | Annual Mean | 99.79%ile of 1-hour mean | Max 1-hour mean |
| **Point of maximum impact** | | | |
| **Including buildings** | **0.45** | **39.81** | **56.18** |
| Excluding buildings | 0.39 | 9.10 | 12.35 |
| **Maximum impacted receptor** | | | |
| **Including buildings** | **0.27** | **9.27** | **12.14** |
| Excluding buildings | 0.27 | 6.65 | 7.43 |

As shown, modelling the presence of buildings results in higher concentrations, particularly for short-term concentrations. This effect is more pronounced at the point of maximum impact. It is considered appropriate to include buildings in the dispersion model as this represents a realistic approach.

## 2.3 Grid resolution

The sensitivity of the results to the grid resolution used has been considered by comparing the results with a grid resolution of 50 m as per Uniper's AQA (see section 4.4 of the AQA) and with finer grid resolutions of 20 m and 10 m. The resolution of 20 m has been chosen as this is not a divisor of 50 m, so the grid points will not be substantially duplicated which would reduce the value of the sensitivity analysis.

The following parameters were kept constant:

- Stack height – 35 m
- Dispersion site surface roughness – 0.3;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – model default;
- Meteorological site Monin-Obukhov length – model default;
- Meteorological data used – Rostherne 2016.

The contribution of the Facility to the ground level concentration of oxides of nitrogen at the point of maximum impact is presented in Table 3 for each scenario.

*Table 3: Effect of Grid Resolution*

| Grid resolution used in model (m) | Oxides of Nitrogen PC (µg/m³) | | |
|---|---|---|---|
| | Annual Mean | 99.79%ile of 1-hour mean | Max 1-hour mean |
| **Point of maximum impact** | | | |
| **50 m** | **0.45** | **39.81** | **56.18** |
| 20 m | 0.45 | 41.66 | 61.30 |
| 10 m | 0.45 | 41.97 | 63.28 |

As shown, the choice of grid resolution has a negligible effect on the maximum annual mean concentration. The finer grid resolutions capture slightly higher short-term concentrations, but the difference will not affect any conclusions. Therefore, the output grid resolution of 50 m used in the AQA is considered sufficiently fine to accurately capture the maximum predicted concentrations. The grid resolution does not affect the impacts at the specific receptor points.

## 2.4 Operating below the design point

Dispersion modelling has been undertaken using the emission parameters based on continual operation at maximum load. In reality the demand on the boilers will be lower and vary depending on the processes ongoing at the site. When operating with lower loading the volumetric flow rate and the exit velocity of the exhaust gases would reduce. The effect of this would be to decrease the quantity of pollutants emitted but also to reduce the buoyancy of the plume due to momentum. The reduction in buoyancy, which would lead to reduced dispersion, would be more than offset by the decrease in the amount of pollutants being emitted, so that when running below maximum capacity the impact of the new boilers at areas of relevant exposure would be reduced.