FICHTNER
Consulting Engineers Limited

Powerfuel Portland Ltd

Portland ERF

Environmental Permit Application Reference EPR/AP3304SZ/A001
Clarification on Emergency Diesel Generator Modelling

1 Request

The Environment Agency (EA) has requested further clarification following its review of the air quality modelling report submitted in response to the Schedule 5 Notice. This relates to the modelling of emissions from the emergency diesel generator (EDG).

Specifically, the EA noted the following:

- *The proposed EDG stack of 8m height is located in close proximity to the northeast and northwest facades of site buildings with heights of 41m and 36.5m respectively. As a result, there is poor dispersion and an area of Portland SSSI/SAC close to the installation is located within the cavity region of the buildings. Within this cavity region, which extends to approximately 3 building heights distance (or c.125m) to the south of the buildings, there are high uncertainties in the amount of pollutant recirculation due to high turbulence caused by building downwash.*
- *Due to these high uncertainties we have little confidence in short-term (daily) NOx predictions at the area of Portland SSSI/SAC due south of the installation within the cavity region where the building downwash effect is particularly pronounced.*
- *We therefore cannot rule out exceedances of the daily NOx Critical level of 75µg/m^3 at areas of the Portland SSSI/SAC located within the cavity region of the buildings. In addition, there is limited evidence to quantify uncertainties in modelling predictions in regions of such turbulent flow regimes and, therefore, predictions are highly uncertain.*
- *We consider that exceedances of the daily NOx Critical level at Portland SSSI/SAC are unlikely at locations beyond the cavity region of the site buildings.*

Given these comments, the EA made the following request.

We will need you to review your EDG assessment and further consider the potential for impact on Portland SSSI/SAC in light of the above information. In doing so you may wish to consider the following:

- *Consider whether a change to operating conditions and/or site configuration would mitigate for the above uncertainty. Should you propose changes to operating conditions and/or plant configuration, remodelling should be undertaken to support further assessment.*
- *Consider the applicability of an alternative daily NOx Critical level in accordance with the WHO AQ guidelines for Europe (2000).*

In this document, we have clarified why we consider that the uncertainties around the building cavity region do not affect the results of the assessment, confirmed that the current Critical level for oxides of nitrogen (NOx Critical level) remains applicable and clarified the context of the assessment. As a result, we do not consider that the EDG assessment needs to be amended and we continue to consider that exceedances of the daily NOx Critical level at Portland SSSI/SAC due to emergency operation of the EDG are unlikely.

2 Response

2.1 Effect of uncertainty

It is agreed that there is some uncertainty around the behaviour of emissions around buildings. The ADMS dispersion model parameterises the air flow around the buildings. This approach is based on wind tunnel experiments and results in a series of equations for different zones. This modified air flow is then used to calculate the effect on the dispersion of emissions. This includes the calculation of a well-mixed region downwind of the building where the concentration is assumed to be uniform. The dimensions of this region are defined by the building height and width. Whether or not the plume is fully entrained within the building wake is determined and this is then used to determine the dispersion characteristics. Where the model determined that the release is fully entrained, which is the case for the EDGs when the wind is blowing from the north, the concentration within the well mixed region is determined based on the volume of the well-mixed region and the cavity mean residence time. This would mean that for low wind speeds the concentration would be greatest. However, this parameterisation means that a constant concentration is assumed for this zone.

Therefore, the ground level concentration could be higher or lower than the average concentration in the building cavity region. In order to assess the impact of this uncertainty, we have focussed on emergency operation as this is the scenario which, as currently modelled, is predicting the potential for an exceedance of the 24-hour NOx Critical level within the Portland SSSI / SAC.

- We have rerun the model with double the emission rate, which effectively considers the case where the ground level concentration is twice the average concentration, allowing for an uncertainty of 100%.
- We have then created a hybrid results file, in which the results from this new model have been used for all points within 100m of the building and the results from the original model have been used for all other points.
- We have then reviewed the overall datafile for each set of weather data to determine the number of weather conditions which lead to an exceedance of the NOx Critical level.

A distance of 100m from the building was selected based on an analysis of a single representative line of weather data which identified that the well mixed region where predicted impacts were constant for the hour extended about 100m from the building.

The results of this assessment are the same as in the original assessment, and the peak concentrations within the SSSI and the SAC do not increase. This means that the concentration in the SSSI or SAC within the cavity region, even when doubled, remains lower than the concentration in the SSSI or SAC beyond the cavity region for all weather conditions which can cause an exceedance. In other words, the greatest impacts on the SSSI and SAC from the EDG are outside the building cavity region.

Figure 1 has been produced to demonstrate the impact for a single line of weather data. The area of constant concentration has been identified. As shown, for this line of weather data the maximum concentration occurs outside of this well mixed region and within the SAC. The concentration is presented as a percentage of the value in the cavity region for the single line of weather data.

Therefore, we consider that the results of the assessment are robust, even allowing for the uncertainty around the building cavity region, and so the conclusions of the assessment are unchanged.

2.2 Effect on ecological receptors

Although we consider that the conclusions of our assessment are robust and so exceedances of the daily NOx Critical level are unlikely, we have considered whether we can use a higher critical level for NOx.

The World Health Organisation (WHO) states that:

> *"Experimental evidence exists that the CLE [critical level] decreases from around 200 µg/m^3 to 75 µg/m^3 when in combination with O_3 or SO_2 at or above their critical levels. In the knowledge that short-term episodes of elevated NOx concentrations are generally combined with elevated concentrations of O_3 or SO_2, 75 ug/m^3 is proposed for the 24 h mean."*

The Institute of Air Quality Management (IAQM) has stated that:

> *"If a regulator does require the use of the short term NOx critical level, given the low UK SO_2 concentrations IAQM consider it is most appropriate to use 200 ug/m^3 as the short term critical load".*[1]

Therefore, we have reviewed background concentrations of sulphur dioxide and ozone in the local area and compared with the relevant critical levels.

- The background sulphur dioxide levels are well below the critical level for sulphur dioxide of 20 µg/m^3. The annual mean background concentration displayed on APIS is 2.3 ug/m^3. Therefore, there is little risk that the annual mean concentration would be above 20 ug/m^3 even including more refined contributions from the port or contributions from the proposed energy recovery facility (ERF).
- The critical level for ozone is an AOT40 of 3,000 ppb/hr for natural and semi natural vegetation[2].The Air Quality Directive (2008/EC/50) sets a long term objective of 6,000 ppb hAOT40. The AOT40 is defined as the accumulated concentration above 40 parts per billion during daylight hours during the growing season (May to July). The WHO explain that this should be calculated as an average over a 5-year period[3].

  We have analysed ozone concentrations measured at Bournemouth, Chilbolton, Charlton Mackrell, Portsmouth and Southampton, which are the five closest monitoring sites. This has shown that the levels at background sites (Chilbolton and Charlton Mackrell) were greater than in urban areas, which is expected as higher levels of nitrogen oxides in urban areas are associated with lower levels of ozone.

  In 2018 and 2020 there were a few periods across the growing season in which elevated ozone concentrations were reported across the UK at all site types, which means that in 2018 the AOT40 exceeded the long term objective set in the Air Quality Directive (2008/EC/50) critical level of 6,000 ppb h across many sites in the UK. As a five year average, the AOT40 remained below 6000 ppb h at all of the local sites but exceeded the critical level for vegetation of 3000 ppb h at the two background sites and in Bournemouth.

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[1] IAQM A guide to the assessment of air quality impacts on designated nature conservation sites, 2020

[2] Table III.17 of ICP Vegetation Report 2017 Chapter 3 and WHO, Air Quality Guidelines for Europe, 2nd Edition Chapter 12 Effects of ozone on vegetation: critical levels, 2000

[3] WHO, Air Quality Guidelines for Europe, 2nd Edition Chapter 12 Effects of ozone on vegetation: critical levels, 2000

The area close to the port is influenced by local sources of NOx emissions, but the surrounding area is more rural. Therefore, the ozone levels are likely to be lower than in more rural locations but higher than in urban areas.. Given that the ozone levels in Bournemouth, which is the closest urban area, and in the rural areas exceed the critical level of 3,000 ppb h, it is not possible to confirm that ozone levels around Portland are below this critical level. However, at all the sites the 5-year average concentration is below the long term objective in the Air Quality Directive.

Table 1: Analysis of ozone levels –

Site	AOT40 (ppb h) during the growing season 1 May to 31 July					
	2017	2018	2019	2020	2021	5-yr Average
Bournemouth	2,413	**6,016**	1,654	**4,566**	2,466	**3,423**
Charlton Mackrell	1,695	-	-	**3,218**	**5,198**	**3,370**
Chilbolton Observatory	2,664	**8,446**	1,794	**4,051**	1,660	**3,723**
Portsmouth	1,564	2,013	493	-	2,498	1,642
Southampton Centre	1,241	**4,524**	401	2,601	839	1,921
Notes: AOT40 calculated between 1 May and 31 July and only results presented where data capture for the growing season is greater than 75%.						

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The WHO states that the NOx Critical level decreases (Fichtner's emphasis) "*in combination with O_3 <u>or</u> SO_2 at or above their critical levels*". As demonstrated above, the levels of sulphur dioxide, even when considering the contribution from the Facility, would remain below the critical level for sulphur dioxide. There is slightly more uncertainty over the ozone levels. As sulphur dioxide is well below the critical level, we consider that a critical level of 75 ug/m^3 is probably too stringent. However, there is not sufficient evidence to justify that a critical level of 200 ug/m^3 is appropriate for this area.

Therefore, we consider that it is more precautionary to consider a daily NOx Critical level of 75µg/m^3 and we do not propose to change the assessment,

2.3 Context

It is important to consider the context. The conditions envisaged by the EA, under which the building cavity region would overlap with small parts of the SSSI and even smaller parts of the SAC[4], would only occur if the wind were coming from the north-east quadrant. The emissions from the EDG would need to rise, be taken over the 41m building and then drop into the building cavity region on the other side of the building. It is anticipated that it would be more common for the emissions to be taken around the building, and indeed the presence of the building between the EDG and the ecological sites was considered to be a benefit.

4 The area of the SSSI within 100m of the building is about 1.4 hectares. The area of the SAC within 100 m of the building is around half of this (0.73 hectares). For context, the area of the SSSI is 351.83 ha and the area of the SAC is 1446.16ha.

As set out in the response to the Schedule 5 notice, the EDG would operate under the following scenarios:

- For testing and maintenance purposes – expected to be tested every two weeks for less than 30 minutes; and
- In the event of loss of grid connection to maintain operation of the abatement and control systems to enable a safe shutdown the ERF – assumed to be typically no more than 4 hours for any one event, and expected to happen less than once a year, given the historic resilience of the local grid.

Under the testing scenario, the modelling predicted no exceedances of the daily NOx Critical Level in the SSSI or the SAC, even including a high background concentration.

Under the emergency scenario, the modelling predicted some exceedances of the daily NOx Critical Level in the SSSI or the SAC, but only under limited weather conditions.

It is also important to consider the situation which is being modelled. In the event that there is a loss of the grid connection to the site and the ERF needs to be shutdown, either because it is affected by the loss of power or for some other reason, the emergency generator will need to run. This is expected to happen less than once a year. If the emergency generator runs, then the weather conditions which could cause an exceedance of the daily NOx critical level of 75 $\mu g/m^3$, assuming a high background concentration, only occur about 1.4% of the time. Hence, in a year, there is at most a 1.4% chance of a single exceedance of the critical level for NOx in a small part of the SSSI. The chance of an exceedance in a small part of the SAC is even smaller, 0.5%.

The EA's concern is that it is possible that the chance of an exceedance could be higher due to uncertainty in the modelling. We do not consider that this is the case, as explained above. However, the chance of an exceedance would need to increase by a factor of three before it would exceed the EA's criteria for exceedances being unlikely in the SSSI, and it would need to increase by a factor of 10 for the SAC. Furthermore, even if there is a single exceedance in a particular year, this will not have a significant impact on the local habitat as a single isolated day of high NOx concentrations will not affect the vegetation significantly.

3 Conclusion

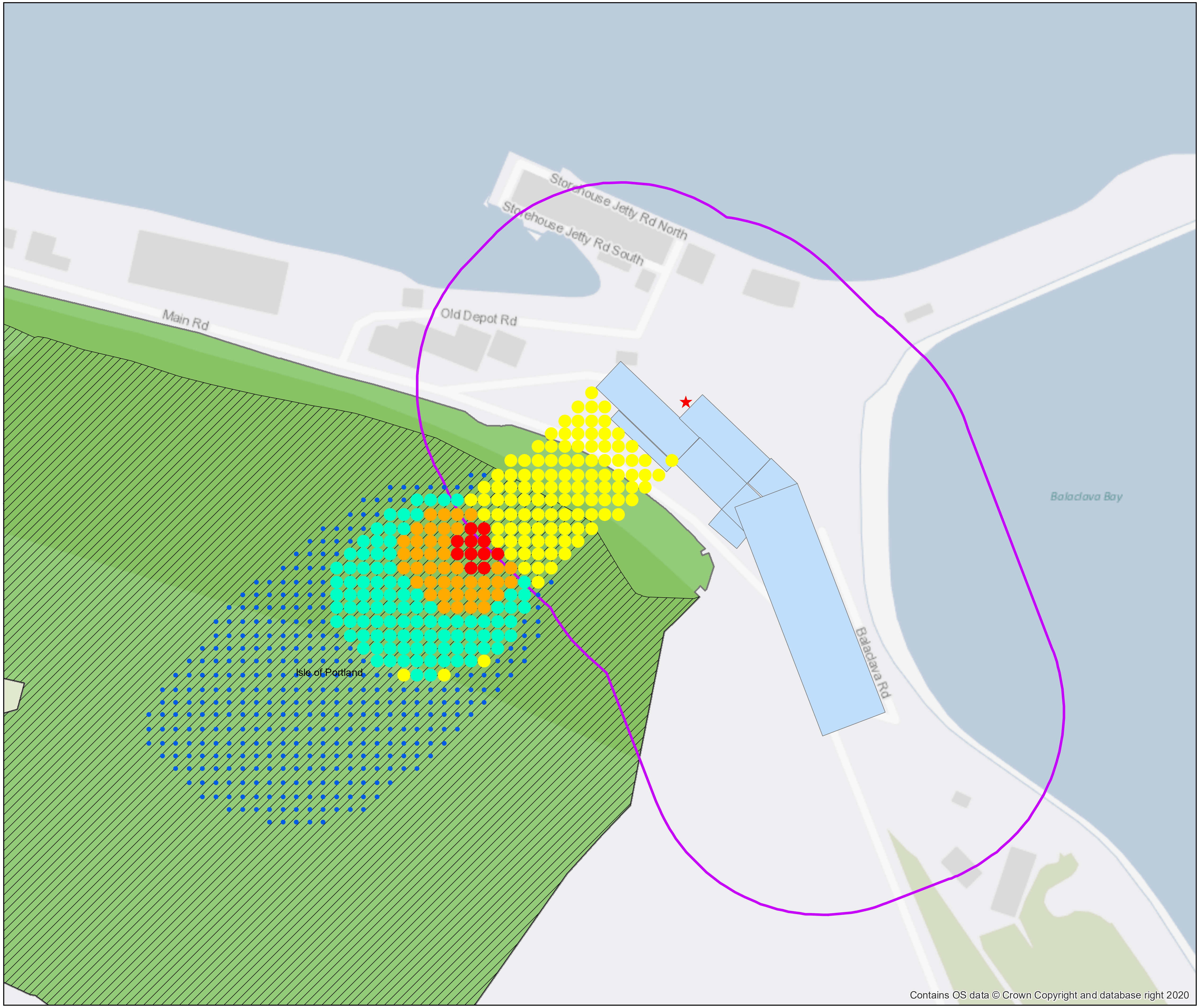
As requested by the EA, we have clarified some points around the effect of emissions from the EDG on the nearby ecological receptors.

1. We have confirmed that uncertainties in the modelling of the building cavity region do not change the results of the assessment.
2. We have confirmed that the daily critical load for nitrogen oxides which is appropriate for this area should be kept as 75 $\mu g/m^3$ on a precautionary basis.
3. We have clarified the very limited circumstances in which the building cavity region is relevant and the very small area of the ecological receptors which could be affected by the building cavity region.

Therefore, we consider that the assessment of the impact of emissions from the emergency generator is robust and there is no need to change the methodology, the operating conditions or the plant configuration.

Rosalind Flavell
Senior Environmental Consultant

Stephen Othen
Technical Director



Legend

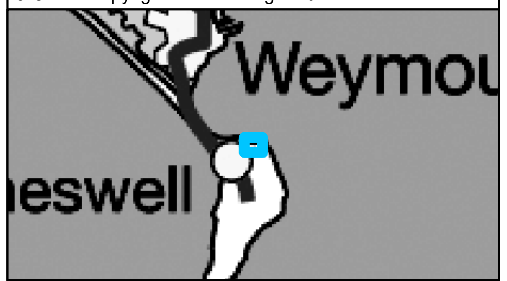
- 100m Building buffer
- SAC within 10km
- SSSi within 2km
- Cavity region

Max as % of cavity region

- <50%
- 50 - 100%
- 100 - 150%
- 150 - 200%
- >200%

Note: Impacts presented as % of cavity region for a single line of weather data

Client:	Powerfuel Portland Ltd
Site:	Portland EfW
Project:	2953
Title:	Figure 1 - Building Cavity Analysis
Drawn by: Rosalind Flavell	Date: 09/03/2022



0 0.02 0.04 0.08 km

N

Scale: 1:2,000

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