West Burton Solar Project

Environmental Statement

Appendix 17.4: BESS Fire Technical Note

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West Burton
SOLAR PROJECT

West Burton Solar Project

Potential Air Quality Impact Assessment From A Fire Incident

784-B031437
1st February 2023

PRESENTED TO

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NON-TECHNICAL SUMMARY

This report presents the findings of a fire accident impact assessment, which forms one of the Technical Appendices of ES Volume 3. ES Volume 3 consists of a set of appendices in support of ES Volume 1, Chapter 15: other Environmental Topics.

Potential effects of a fire incident on the surrounding residents and public have been assessed using the 'air quality category' which is classified as 'good', 'moderate', 'unhealthy', 'very unhealthy' or 'hazardous'. Each category corresponds to a different level of health concern. The air quality category in this assessment is classified using the values of fire-generated particulate matter (equivalent to $PM_{2.5}$) concentrations in air. Furthermore, air quality category zones have been determined according to the air quality category to make it easy for public/site manager/fire safety representative to quickly to take appropriate actions in case of a fire.

Four air quality category zones have been identified as below:

- Hazardous Zone – within 10 metres from a fire;
- Unhealthy Zone – 11 to 20 metres from a fire;
- Moderate/Unhealthy for Sensitive Groups Zone – 21 to 200 metres from a fire; and
- Good Air Quality Zone – more than 200 metres from a fire.

As a fire could occur at any location within the development during the site construction, operational and decommissioning phases, generic receptor locations have been used in the assessment. In case of a fire, the site manager/fire safety representative will need to assess the fire locations, wind directions and surrounding receptors. The site manager/fire safety representative will take appropriate actions accordingly.

The actions to be taken include (1) to inform any potential affected residents within the zones and to advise public about health effects of smoke, related symptoms, and ways to reduce exposure; (2) to cancel outdoor events and/or (3) to move affected residents to a cleaner air location.

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1.0 INTRODUCTION

Tetra Tech Limited have prepared a potential air quality impact assessment from a fire incident in support of a planning application for West Burton Solar Project (the 'Scheme').

- The West Burton Solar Project consists of four land parcels (the 'Site" or 'Sites) described as West Burton 1, 2, and 3, for a proposed solar project.

The Scheme comprises the installation of solar photovoltaic (PV) generating panels and on-site energy storage facilities across proposed sites in Lincolnshire and Nottinghamshire together with grid connection infrastructure. The proposed development would allow for the generation, storage and export of up to around 480 megawatts (MW) renewable energy.

A fire accident can be considered to be an occurrence involving smoke, heat, and flames causing property damage, such as solar panels and substations.

A fire impact assessment considered the smoke impact on the surrounding residents/population when a fire break out at one selected location within the Scheme. Fire affected zones/areas have been identified and those predicted fire impact zones/areas can be applied to or overlaid over any locations within the Scheme since it is not practical to model every location as a fire source and a fire could occur anywhere within a Site at Scheme.

Effect of a fire incident has been assessed using the 'Air Quality Category' which is classified as 'good', 'moderate', 'unhealthy', 'very unhealthy' or 'hazardous'. The 'Air Quality Category' has been defined according to the fire-generated particulate matter (equivalent to $PM_{2.5}$) concentrations in air.

A fire action plan for protecting human health from fire smoke has been recommended.

This report is produced to form one of Technical Appendices of ES Volume 3. ES Volume 3 consists of a set of appendices in support of ES Volume 1, Chapter 15: other Environmental Topics.

1.1 SITE LOCATION

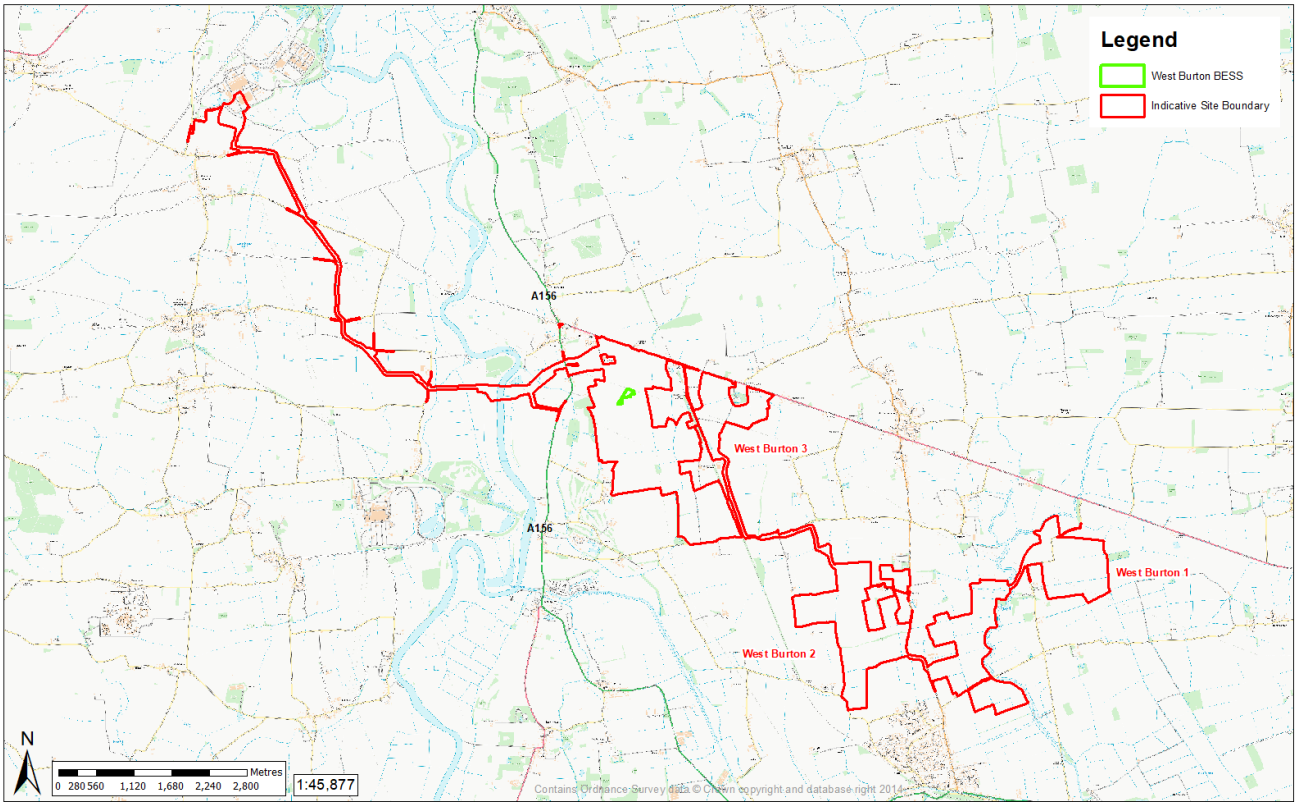
The development (the Scheme) consists of 3 areas of West Burton 1 to West Burton 3. The details of the locations are presented in **Figure 1-1**.

- West Burton 1 – which is located approximately 7 km northwest of Lincoln;
- West Burton 2 – which is located approximately 8 km northwest of Lincoln; and
- West Burton 3 – which is located approximately 12 km northwest of Lincoln.

The proposed development sites are surrounded mainly by agriculture areas.

This report is focused on the assessment of the potential Impacts from solar panels or substation equipment fire generated dust and smoke on surrounding sensitive receptor locations.

Figure 1-1. Site Locations



2.0 PARTICULATES AND SMOKE FROM A FIRE

2.1 SMOKE COMPOSITION

The smoke released by any type of fire (forest, brush, crop, structure, tires, waste or wood burning) is a mixture of particles and chemicals produced by incomplete burning of carbon-containing materials. All smoke contains carbon monoxide, carbon dioxide and particulate matter (PM or soot). Smoke can contain many different chemicals, including aldehydes, acid gases, sulphur dioxide, nitrogen oxides, polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, styrene, metals and dioxins. The type and number of particles and chemicals in smoke varies depending on what is burning, how much oxygen is available, and the burn temperature (Department of Health of New York State).

2.2 PARTICULATES FROM A FIRE

Particle levels are a principal concern in a fire smoke. The size of particles in the air we breathe affects their potential to cause health problems. Particle pollution may contain substances like carbon, sulphur and nitrogen compounds, metals and organic chemicals. Particle size is usually measured in microns, which are units of one millionth of a metre. Coarse particles range from 2.5 - 10 microns in diameter (Smoke Exposure from Wildland fires, interim Guidelines for Protecting community Health and wellbeing, Manitob Health January 26, 2021).

Fine particles, with diameters less than 2.5 microns are often linked to health effects. Particles in this size range are slow to clear from the lungs when they are inhaled.

Particles from smoke tend to be extremely small, with a size range near the wavelength of visible light (0.4 to 0.7 microns). At this size range, smoke particles efficiently scatter light and make it difficult to see, explaining why people often become disoriented in smoke. It also explains why some smoke particles can be inhaled deeply into the lungs and why these are a greater health concern than larger particles.

2.3 HEALTH EFFECTS OF FIRE SMOKE

Particulate matter exposure is the principle public health threat from short-term smoke exposure. The health effects of smoke from wildland fires range from eye, nose or throat irritation to serious problems such as reduced lung function, bronchitis, exacerbation of asthma and even a risk of death. People who are otherwise healthy may have irritated eyes, increased mucus production in the nose or throat, and/or coughing or difficulty breathing, especially during exercise. People with existing respiratory or cardiovascular conditions may experience aggravation of existing conditions.

Exposure to high levels of smoke should be avoided. Individuals are advised to limit their physical exertion if exposure to high levels of smoke cannot be avoided. Individuals with cardiovascular or respiratory conditions (e.g., asthma), fetuses, infants, young children, and the elderly may be more vulnerable to the health effects of smoke exposure (Department of Health of New York State).

3.0 EXTANT POLICY, LEGISLATION AND RELEVANT AGENCIES

The health effects of a fire on public health has been assessed against the fire-generated particulate matter levels and their associated air quality category (good to hazardous levels).

3.1 DOCUMENTS CONSULTED

The following documents were consulted during the undertaking of this assessment:

Legislation and Best Practice Guidance

- National Planning Policy Framework, Ministry for Housing, Communities and Local Government, Revised July 2021;
- Planning Practice Guidance: Air Quality, Ministry for Housing, Communities and Local Government, November 2019;
- The Air Quality Standards Regulations (Amendments), 2016;
- The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Defra, 2007;
- The Environment Act, 1995;
- Local Air Quality Management Technical Guidance LAQM.TG16, Defra, 2021;
- Design Manual for Roads and Bridges, Volume 11, Section 3, Part 1, LA 105 Air quality, November 2019;
- Land-Use Planning & Development Control: Planning for Air Quality, EPUK & IAQM, 2017;
- Guidance on the Assessment of Dust from Demolition and Construction, IAQM, 2014;
- National Operational Guidance: Control measure – Cordon controls: Hazardous materials, National Fire Chiefs Council (NFCC), 2022; and
- A Guide to the Assessment of Air Quality Impacts on Designated Nature Conservation Sites (Version 1.0), IAQM, May 2020.

Websites Consulted

- Google maps [redacted]
- The UK National Air Quality Archive [redacted]
- Department for Transport Matrix [redacted]
- [redacted]
- Multi-Agency Geographic Information for the Countryside (http://magic.defra.gov.uk/);
- Planning Practice Guidance (http://planningguidance.planningportal.gov.uk/);
- West Lindsey District Council (https://www.west-lindsey.gov.uk/); and
- Bassetlaw District Council (https://www.bassetlaw.gov.uk/).

Site Specific Reference Documents

- Annual Status Report (ASR) 2021, West Lindsey District Council, June 2021;
- Central Lincolnshire Local Plan 2012 – 2036, adopted April 2017. Central Lincolnshire covers the combined area of the City Of Lincoln, North Kesteven, and West Lindsey;
- 2020 Air Quality Annual Status Report (ASR) for Bassetlaw District Council, August 2020;
- Bassetlaw Draft Worksop Central Development Plan Document (DPD), June 2021; and

- Bassetlaw Local Plan 2020 – 2037, publication version, August 2021.

European Legislation

European air quality legislation is consolidated under Directive 2008/50/EC, which came into force on 11th June 2008. This Directive consolidated and replaced previous legislation which was designed to deal with specific pollutants in a consistent manner and provides new air quality objectives for fine particulates. The consolidated Directives include:

- **Directive 1999/30/EC** – the First Air Quality "Daughter" Directive – sets ambient air limit values for nitrogen dioxide and oxides of nitrogen, sulphur dioxide, lead and particulate matter;
- **Directive 2000/69/EC** – the Second Air Quality "Daughter" Directive – sets ambient air limit values for benzene and carbon monoxide;
- **Directive 2002/3/EC** – the Third Air Quality "Daughter" Directive – seeks to establish long-term objectives, target values, an alert threshold and an information threshold for concentrations of ozone in ambient air;
- **The 2008 Ambient Air Quality Directive (2008/50/EC)** - The Directive sets limits for key pollutants in the air we breathe outdoors. These legally binding limit values are for concentrations of major air pollutants that impact public health, such as particulate matter (PM_{10} and $PM_{2.5}$) and nitrogen dioxide (NO_2). The directive also sets limit values for a range of other pollutants, such as ozone, sulphur dioxide and carbon monoxide.
- **The 4th air quality daughter directive (2004/107/EC)** – the Directive sets targets for levels in outdoor air of certain toxic heavy metals and polycyclic aromatic hydrocarbons. Both directives are introduced into the UK through the Air Quality Standards Regulations 2010.

The European Commission (EC) Directive Limits, outlined above, have been transposed in the UK through the Air Quality Standards Regulations 2010. In the UK responsibility for meeting ambient air quality limit values is devolved to the national administrations in Scotland, Wales and Northern Ireland.

National Legislation

Air Quality Standards Regulations 2010 (as amended)

The consolidated EU directive referred to above is implemented into domestic law by the Air Quality Standards Regulations 2016i. The limit values (re ambient air quality) defined within those Regulations are legally-binding and apply across England, with the exception of the carriageway and central reservation of roads where the public does not normally have access, on factory premises or at industrial locations (where health and safety provisions apply) and any locations where the public does not have access and there is no fixed habitation.

The Air Quality Standards Regulations 2010 (as amended) set legally binding limits for concentrations of certain air pollutants (i.e. “limit values”). This is with the intention of avoiding, preventing or reducing harmful effects on human health and the environment as a whole. To the extent that any concentrations exceed limit values, the Secretary of State is required to prepare an “air quality plan” with measures so as to achieve the limit value.

Environmental Protection Act 1990

The Environmental Protection Act 1990 prescribes a statutory nuisance as air quality pollutants emitted from premises (including land), through smoke, fumes or gases, dust, steam or smell that is prejudicial to health or a nuisance.

Local Authorities are required to investigate any public complaints regarding air quality, and if they are satisfied that a statutory nuisance exists, or is likely to occur or recur, they must serve an abatement notice. A notice is served on the person responsible for the nuisance. It requires either simply the abatement of the nuisance or works to abate the nuisance to be carried out, or it prohibits or restricts the activity.

The UK Air Quality Strategy

The UK Air Quality Strategy is the method for implementation of the air quality limit values in England, Scotland, Wales and Northern Ireland and provides a framework for improving air quality and protecting human health from the effects of pollution.

For each nominated pollutant, the Air Quality Strategy sets clear, measurable, outdoor air quality standards and target dates which should be aimed for; the combined standard and target date is referred to as the Air Quality Objective (AQO) for that pollutant. Adopted national standards are based on the recommendations of the Expert Panel on Air Quality Standards (EPAQS) and have been translated into a set of Statutory Objectives within the Air Quality (England) Regulations 2000.

The AQOs for pollutants included within the Air Quality Strategy and assessed as part of the scope of this report are presented in Table 3-1 along with European Commission (EC) Directive Limits and World Health Organisation (WHO) Guidelines.

Table 3-1. Air Quality Standards, Objectives, Limit and Target Values

Pollutant	Applies	Objective	Concentration Measured as	Date to be achieved and maintained thereafter	European Obligations	Date to be achieved and maintained thereafter	New or existing
Particles (PM_{10})	UK	50 µg/m^3 not to be exceeded more than 35 times a year	24 Hour Mean	31st December 2004	50 µg/m^3 not to be exceeded more than 35 times a year	1st January 2005	Retain Existing
	UK	40µg/m^3	Annual Mean	31st December 2004	40µg/m^3	1st January 20105	
Particles ($PM_{2.5}$)	UK	20µg/m^3	Annual Mean	1st January 2020	EU Exit	The Environment (Miscellaneous Amendments) (EU Exit) Regulation 2020	

It can be seen that the air quality standards/objectives are based on the average exposure during 1-year or 24-hour period. Considering a fire would las for a short period of time before it is extinguished. Therefore, the air quality standards in the table above have not been used in this assessment. Instead, fire-generated particulate matter ($PM_{2.5}$) levels and their associated air quality category (good to hazardous levels) have been used.

Local Air Quality Management

Under Section 82 of the Environment Act (1995) (Part IV) LAs are required to periodically review and assess air quality within their area of jurisdiction under the system of LAQM. This review and assessment of air quality involves assessing present and likely future air quality against the AQOs. If it is predicted that levels at the

façade of buildings where members of the public are regularly present (normally residential properties) are likely to be exceeded, the LA is required to declare an Air Quality Management Area (AQMA). For each AQMA the LA is required to produce an Air Quality Action Plan (AQAP), the objective of which is to reduce pollutant concentrations in pursuit of the AQOs.

3.2 PLANNING AND POLICY GUIDANCE

National Policy

The National Planning Policy Framework (NPPF), revised July 2021, principally brings together and summarises the suite of Planning Policy Statements (PPS) and Planning Policy Guidance (PPG) which previously guided planning policy making. The NPPF states that:

> Paragraph 174
>
> *"Planning policies and decisions should contribute to and enhance the natural and local environment by:*
>
> *e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans."*
>
> Paragraph 186
>
> *"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas or Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic or travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan."*

The Planning Practice Guidance (PPG) web-based resource was launched by Department for Levelling Up, Housing and Communities (previously the Ministry for Housing, Communities and Local Government (MHCLG)) on 1 October 2021 to support the National Planning Policy Framework and make it more accessible. A review of PPG: Air Quality identified the following guidance:

> *"When deciding whether air quality is relevant to a planning application, local planning authorities should consider whether the development would:*
>
> *Significantly affect traffic in the immediate vicinity of the proposed development site or further afield. This could be by generating or increasing traffic congestion; significantly changing traffic volumes, vehicle speed or both; or significantly altering the traffic composition on local roads. Other matters to consider include whether the proposal involves the development of a bus station, coach or lorry park;*

adds to turnover in a large car park; or result in construction sites that would generate large Heavy Goods Vehicle flows over a period of a year or more.

Introduce new point sources of air pollution. This could include furnaces which require prior notification to local authorities; or extraction systems (including chimneys) which require approval under pollution control legislation or biomass boilers or biomass-fuelled CHP plant; centralised boilers or CHP plant burning other fuels within or close to an air quality management area or introduce relevant combustion within a Smoke Control Area.

Expose people to existing sources of air pollutants. This could be by building new homes, workplaces or other development in places with poor air quality.

Give rise to potentially significant impact (such as dust) during construction for nearby sensitive locations.

Affect biodiversity. In particular, is it likely to result in deposition or concentration of pollutants that significantly affect a European-designated wildlife site and is not directly connected with or necessary to the management of the site, or does it otherwise affect biodiversity, particularly designated wildlife sites."

Local Policy

West Lindsey District Council

Central Lincolnshire Local Plan 2012 – 2036 was adopted in April 2017. Central Lincolnshire covers the combined area of the City of Lincoln, North Kesteven, and West Lindsey.

The adopted Local Plan details policies for the growth and regeneration of Central Lincolnshire over the next 20 years and beyond, including sites allocated for development and other areas designated for protection.

The policies associated with the air quality include:

*"**Policy LP26: Design and Amenity***

Amenity Considerations The amenities which all existing and future occupants of neighbouring land and buildings may reasonably expect to enjoy must not be unduly harmed by or as a result of development.

Proposals should demonstrate, where applicable and to a degree proportionate to the proposal, how the following matters have been considered, in relation to both the construction and life of the development:

…

s. Adverse impact upon air quality from odour, fumes, smoke, dust and other sources;

…"

The Local Plan contains planning policies and allocations for the growth and regeneration of Central Lincolnshire over the next 20 years. It has been prepared and adopted by the Central Lincolnshire Joint Strategic Planning Committee (CLJSPC).

Bassetlaw District Council

Bassetlaw Local Plan 2020 – 2037, publication version, August 2021, set out the Council's development strategy, planning policies and proposals, including site allocations, to guide land use and planning decisions in the district up to 2037.

The policies associated with the air quality include:

*"**Policy ST44: promoting Healthy, Active Lifestyles***

The Council will, with its partners, create an environment which supports healthy, active, inclusive and safe communities. Healthy, active and safe lifestyles will be enabled by:

…

Ensuring that the current air quality in the District is maintained and, where possible improved;

…"

*"**Policy 48: Protecting Amenity***

The Council will, with its partners, create an environment which supports healthy, active, inclusive and safe communities. Healthy, active and safe lifestyles will be enabled by:

…

Not generate a level of activity, noise, light, air quality, odour, vibration or other pollution which cannot be mitigated to an appropriate standard

…"

Local Plan Section 10.1.6

*"**Improving Air Quality***

10.1.6 … proposals will be expected to minimise and mitigate air pollution and to contribute towards the achievement of relevant air quality objectives, where relevant, an air quality assessment may be required in support of development."

"Policy ST50: Reducing carbon Emissions, Climate Change Mitigation and Adaptation

All proposals, including the change of use of existing buildings and spaces, should seek to reduce carbon and energy impacts in their design and construction in accordance with Policy ST35. Proposals should incorporate measures that address issues of climate change mitigation through:

…

Ensuring no adverse impact on local air quality;

…"

4.0 ASSESSMENT METHODOLOGY

4.1 FIRE INCIDENT IMPACT ASSESSMENT

In general, major accidents or disasters, as they relate to the Scheme, fall into three categories:

- Events that could not realistically occur, due to the nature of the Scheme or its location;
- Events that could realistically occur, but for which the Scheme, and associated receptors, are no more vulnerable than any other development; and
- Events that could occur, and to which the Scheme is particularly vulnerable, or which the Scheme has a particular capacity to exacerbate.

'Accidents' are considered to be an occurrence resulting from uncontrolled developments in the course of construction and operation of a development (e.g. major emission or fire). As such, the potential impacts on local residents from a fire accident, such as solar panel, battery storage and sub-stations fire, are considered and assessed. Particulate matter exposure is the key principle public health threat from short-term smoke exposure, therefore, detailed air dispersion modelling of particulate matter impact from smoke has been undertaken to predict the short-term concentrations $PM_{2.5}$ at residential receptors at downwind locations likely to be affected by incidents including fire.

An approved atmospheric dispersion modelling package (ADMS-Road) has been used in the Air Quality Impact Assessment of a Major Fire Accident, where, smoke levels and their associated air quality category (good to hazardous level) will be estimated using the modelled predicted particulate matter levels, and the potential smoke effects on residential and other sensitive receptors are assessed and mitigation measures are discussed where appropriate.

4.2 PARTICULATE MATTER ($PM_{2.5}$) CONCENTRATIONS AND SMOKE EXPOSURE LEVELS

Health effects from particulate matter ($PM_{2.5}$) levels and fire smoke exposures on residents and public has been assessed.

A guide of "*Smoke Exposure from Wildland fires, interim Guidelines for Protecting community Health and wellbeing, Manitob Health January 26, 2021*", has been used in estimation of the smoke levels and air quality category (good to hazardous level) based on the predicted particulate matter levels from a fire.

Air quality is a measure of how clean or polluted the air is. In this assessment air quality has been divided into 5 categories from good (healthy) to hazardous based on the particulate matter levels in air in **Table 4-1**. Visibility affected by particulate matter is also presented in **Table 4-1**.

Table 4-1. Estimating Smoke Levels from Particulate Matter Concentrations

Air Quality Category	Equivalent approx. $PM_{2.5}$ 1-3-hour average in $\mu g/m^3$	Visibility in km
Good	0-40	15 kms and up
Moderate/Unhealthy for Sensitive Groups	41-175	5-14 kms
Unhealthy	176-300	2.5-4 kms
Very Unhealthy	301-500	1.5-2 kms
Hazardous	over 500	Less than 1 km

Note: Adapted from *Wildfire Smoke: a guide for public health officials:* *http://www.arb.ca.gov/smp/progdev/pubeduc/wfqv8.pdf*

5.0 BASELINE CONDITIONS

This section provides a review of the existing baseline air quality, specifically $PM_{2.5}$, in the vicinity of the sites in order to provide a criterion against which to assess potential fire impact on the surrounding residents and public. Baseline air quality in the vicinity of the site has been defined from a number of sources, as described in the following sections.

5.1 AIR QUALITY REVIEW AND ASSESSMENT

Air Quality Review

As required under section 82 of the Environment Act 1995, Bassetlaw District Council (BDC) and West Lindsey District Council (WLDC) has conducted an ongoing exercise to review and assess air quality within its area of jurisdiction.

5.1.1 Air Quality Monitoring

Monitoring of air quality within BDC and WLDC has been undertaken through automatic and/or non-automatic monitoring methods.

Automatic monitoring

Automatic methods consists of Automatic analysers continuously draw in ambient (outdoor) air and measure the concentration of the pollutant in the sampled air.

Bassetlaw does not have any automatic monitoring sites.

West Lindsey District Council undertook automatic (continuous) monitoring at 1 site during 2020.

Non-automatic monitoring

Non-automatic Networks measure less frequently compared to automatic networks - either daily, weekly or monthly - and samples are collected by some physical means (such as diffusion tube or filter). These samples are then subjected to chemical analysis, and final pollutant concentrations calculated from these results. Non-automatic monitoring method is typically used to measure the NO_2 concentrations.

BDC and WLDC do not monitor for Particulate Matter ($PM_{2.5}$) and (PM_{10}).

5.1.2 Air Quality Management Areas (AQMA)

Bassetlaw District Council currently does not have any AQMAs.

West Lindsey District Council currently does not have any declared AQMAs.

5.1.3 Background Pollutant Mapping

Background pollutant concentration data on a 1km x 1km spatial resolution is provided by the UK National Air Quality Archive[1] and is routinely used to support LAQM and Air Quality Assessments where local pollutant monitoring has not been undertaken.

The relevant background concentrations for this assessment are obtained from the UK National Air Quality Information Archive database based on the National Grid Co-ordinates of 1 x 1 km grid squares nearest to the application site. Those background data was published by Defra in a data group named as "Background Maps 2018" for PM_{10} and $PM_{2.5}$ in August 2020.

The mapped background concentrations adjacent to the site are summarised in **Table 5-1** below.

Table 5-1. Defra Predicted Background Concentrations

Council	Area	UK NGR (m)		2021 Predicted Background Concentration - Annual Mean (µg/m^3)	
		X	Y	PM_{10}	$PM_{2.5}$
West Lindsey District	West Burton 1 & 2	489500	377500	15.76	8.49
West Lindsey District	West Burton 3	485500	380500	15.59	8.45
Bassetlaw District Council	West Burton 4	474500	389500	15.20	8.20
Bassetlaw District Council	West Burton Substation	478500	388500	15.37	8.36

Table 5-1 indicates that there were no background exceedances of the relevant AQOs within the vicinity of the sites during 2021. It should be noted that using 2021 background data would produce a worst-case assessment as background data after 2021 would be less than 2021 data as Defra data includes the year-on-year decrease in the data base.

Furthermore, the maximum annual mean concentrations of $PM_{2.5}$ in the table, for example, 8.49 µg/m^3 have been used in the assessment to produce a worst-case assessment.

5.2 SENSITIVE RECEPTORS

5.2.1 Discrete (Individual) Receptors

Considering the nature of a fire incident, a fire could take place anywhere within the Site and it would last only a short period of time before being extinguished, a set of generic receptors located downwind of a fire has been selected. Four sets of receptors affected by southerly, northerly, easterly and westerly winds are defined as below:

- Receptor Set 1: Receptor locations affected by westerly wind (coming from the west and blowing toward the east), A series of 20 receptors, which were spaced at 10 m intervals, are defined eastward from a fire.
- Receptor Set 2: Receptor locations affected by easterly wind (coming from the east and blowing toward the west), A series of 20 receptors, which were spaced at 10 m intervals, are defined westward from a

[1] [redacted]

fire.

- Receptor Set 3: Receptor locations affected by southerly wind (coming from the south and blowing toward the north), A series of 20 receptors, which were spaced at 10 m intervals, are defined northward from a fire.
- Receptor Set 4: Receptor locations affected by northerly wind (coming from the north and blowing toward the south), A series of 20 receptors, which were spaced at 10 m intervals, are defined southward from a fire.

As a fire could occur at any location within the development during the site construction, operational and decommissioning phases, a set of generic receptor locations at the West Burton 1 site has been selected to represent potential receptors at West Burton 1, 2, and 3 and the substations.

The selected generic receptor locations are presented in **Table 5-2** and are illustrated in **Figure 5-1**.

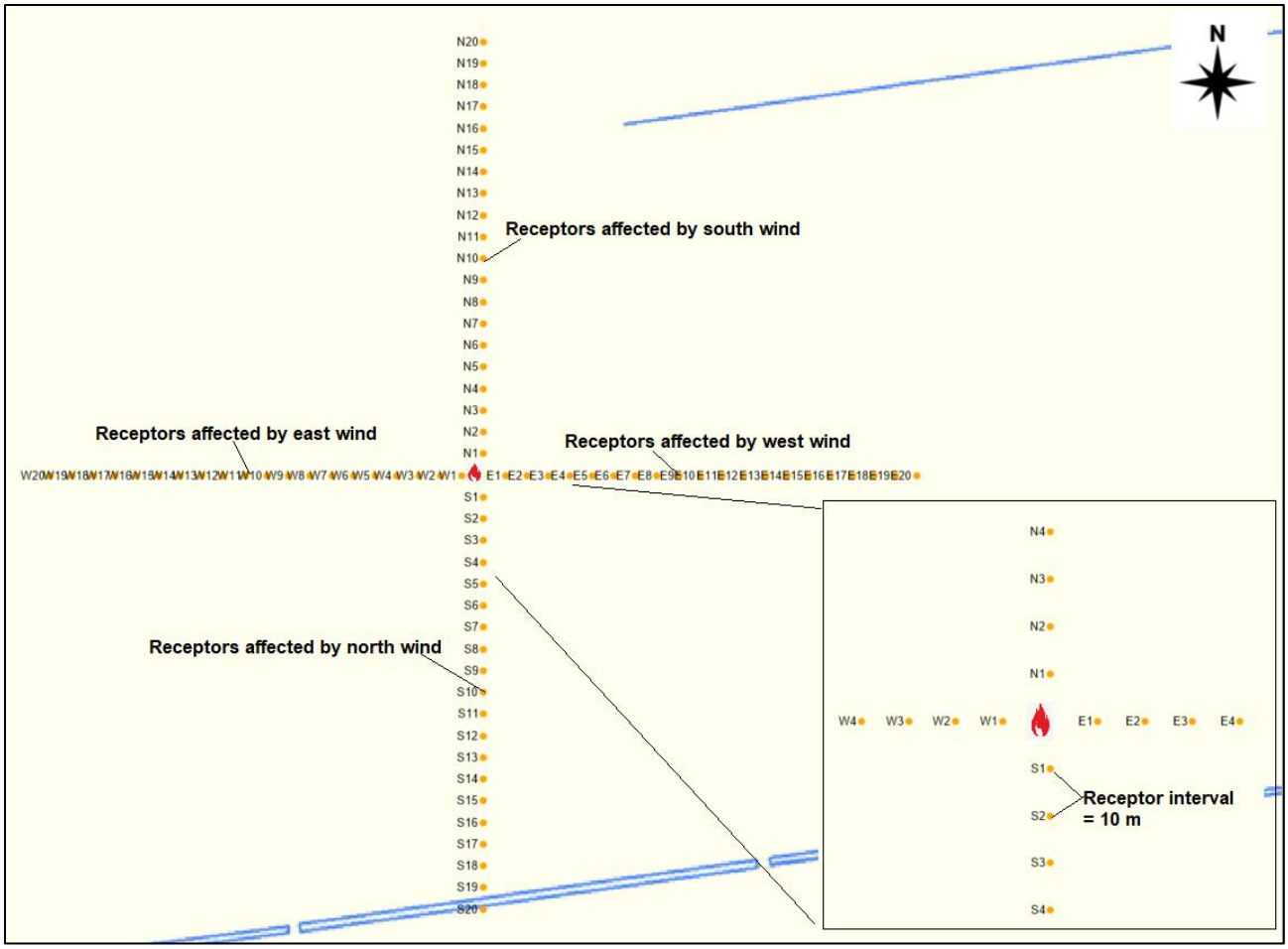
Table 5-2. Selected Sensitive Receptor Locations

Discrete Sensitive Receptor		UK NGR (m)	
		X	Y
E1	E1 (Affected by westerly winds - blowing from west to east)	491610	378400
E2	E2	491620	378400
E3	E3	491630	378400
E4	E4	491640	378400
E5	E5	491650	378400
E6	E6	491660	378400
E7	E7	491670	378400
E8	E8	491680	378400
E9	E9	491690	378400
E10	E10	491700	378400
E11	E11	491710	378400
E12	E12	491720	378400
E13	E13	491730	378400
E14	E14	491740	378400
E15	E15	491750	378400
E16	E16	491760	378400
E17	E17	491770	378400
E18	E18	491780	378400
E19	E19	491790	378400
E20	E20	491800	378400
W1	W1 (Affected by easterly winds - blowing from east to west)	491590	378400
W2	W2	491580	378400
W3	W3	491570	378400
W4	W4	491560	378400
W5	W5	491550	378400
W6	W6	491540	378400
W7	W7	491530	378400
W8	W8	491520	378400
W9	W9	491510	378400

Discrete Sensitive Receptor		UK NGR (m)	
		X	Y
W10	W10	491500	378400
W11	W11	491490	378400
W12	W12	491480	378400
W13	W13	491470	378400
W14	W14	491460	378400
W15	W15	491450	378400
W16	W16	491440	378400
W17	W17	491430	378400
W18	W18	491420	378400
W19	W19	491410	378400
W20	W20	491400	378400
N1	N1 (Affected by southerly winds - blowing from south to north)	491600	378410
N2	N2	491600	378420
N3	N3	491600	378430
N4	N4	491600	378440
N5	N5	491600	378450
N6	N6	491600	378460
N7	N7	491600	378470
N8	N8	491600	378480
N9	N9	491600	378490
N10	N10	491600	378500
N11	N11	491600	378510
N12	N12	491600	378520
N13	N13	491600	378530
N14	N14	491600	378540
N15	N15	491600	378550
N16	N16	491600	378560
N17	N17	491600	378570
N18	N18	491600	378580
N19	N19	491600	378590
N20	N20	491600	378600
S1	S1 (Affected by northerly winds - blowing from north to south)	491600	378390
S2	S2	491600	378380
S3	S3	491600	378370
S4	S4	491600	378360
S5	S5	491600	378350
S6	S6	491600	378340
S7	S7	491600	378330
S8	S8	491600	378320
S9	S9	491600	378310
S10	S10	491600	378300
S11	S11	491600	378290
S12	S12	491600	378280
S13	S13	491600	378270
S14	S14	491600	378260
S15	S15	491600	378250

Discrete Sensitive Receptor		UK NGR (m)	
		X	Y
S16	S16	491600	378240
S17	S17	491600	378230
S18	S18	491600	378220
S19	S19	491600	378210
S20	S20	491600	378200

Figure 5-1. Selected Sensitive Receptor Locations



6.0 DETAILED MODELLING METHODOLOGY

In order to assess the potential air quality impacts from a fire, a quantitative assessment using the third generation ADMS-Road dispersion model has been undertaken. ADMS stands for '*Atmospheric Dispersion Modelling System*'.

The ADMS-Roads pollution model is a comprehensive tool for investigating air pollution problems due to networks of roads that may be in combination with industrial sites (for example, point source). A fire, for example, a solar panel fire, has been modelled as an industrial emission source.

The model utilises hourly meteorological data to define conditions for fire plume rise, transport, diffusion and deposition. It estimates the concentrations at receptor locations for each hour of input meteorology and calculates user-selected hourly short-term averages.

6.1 MODELLING PARAMETER AND AVERAGING PERIOD

Hourly (short-term) particulate matter ($PM_{2.5}$) concentrations have been used to define air quality categories and fire smoke exposure levels for protecting human health.

6.2 MODELLING OF FIRE USING ADMS-ROADS

In ADMS-Roads Modelling, a fire is assumed to consist of a flaming region directly above the fuel source, for example, solar panels. Above the flaming region is a hot region, which is referred to as the buoyant plume. In the buoyant plume the combustion products from the fire are carried upwards in the strong buoyant flow generated by the heat released. The combination of the fire and associated buoyant plume is referred to as the fire plume.

ADMS-Road has been used to model the dispersion of combustion products from the top point of the buoyant plume. The modelled release height H = fuel height + flame height.

6.3 PARTICULATE MATTER ($PM_{2.5}$) EMISSION RATES FROM A FIRE

Tetra Tech have reviewed and studied few solar panels fire incident videos available on the internet. A number of assumptions have been made in building a conceptual model to simulate a solar panel file.

1. A solar panel is between 0.8 m (the front edge) and 2.5 m (the back of the panel) above ground level. A solar panel fuel height of 1 m is assumed;
2. Fire flame height 1 m;
3. Single solar panel size (L x W): 1680 mm x 966 mm;
4. Single solar panel weight: 18 to 20 kg;
5. Assuming 9 panel on fire with flame at same time;
6. Solar panel combustible percentage: assuming 100%; and
7. Time for a solar panel to be burn out: 30 minutes.

The fire gas volumes, particulate matter ($PM_{2.5}$) mass emissions and other modelling parameters are presented in **Table 6-1**.

Table 6-1. Mass Emissions and Emission Source Parameters for Fire Modelling

Parameter	9 Single Solar Panel on Fire	Unit
No. of Solar Panel on Fire	9	-
Single solar panel weight	20	kg
Total combustible weight	180	kg
Fire exhaust gas volume at 20 °C and 101.325 Pa	1031.7 [a]	Nm^3
Heat release from a fire, using hard PVC as material	20	MJ/kg
Time for a solar panel to be burn out: 30 minutes	30	minutes
Fire gas volume at reference condition of 273 K, 101.3kPa, dry gas	0.57	Nm^3/s
Fire gas temperature	304 [b]	°C
Fire gas volume at fire gas temperature	1.13	Am^3/s
Particulate emission rate ($PM_{2.5}$)	19 [c]	Kg/tonne of panel
	4.01	g/s
Panel area on fire	15.06	m^2
Fire gas upward velocity	10	m/s
Flame height + fuel height	2	m

Note:

a. *Derived from the wood dry flue gas of 4.892 Nm^3/kg and Wood heat release of 17MJ/kg.*
b. *Derived from the peak temperature from a car fire; and*
c. Particulate emission rates from 4.8 kg/tone (green waste to 19 kg/tonne (agricultural leaves). The maximum being used.

6.4 METEOROLOGICAL DATA

The meteorological data (2019) used in the assessment is derived from Scampton weather station, which is considered representative of conditions within the vicinity of the site, with all the complete parameters necessary for the ADMS-Road model. Reference should be made to Figure 6-1 for an illustration of the prevalent wind conditions at the weather station.

The met data have been modified/adjusted to have the wind blowing constantly at one direction, for example, wind always blow from the south, north, east or west. The adjustment is necessary for assessing fire impact at downwind locations for a certain short period. The wind roses of 2019 met (not adjusted) and the adjusted wind conditions from the south, north, east and west are presented in Figure 6-1 (next page).

6.5 SURFACE CHARACTERISTICS

The land uses surrounding the Site are currently being used for agricultural purposes in arable production. A surface roughness value of 0.3 (agricultural areas (max)) has been used in the modelling for a worst-case assessment.

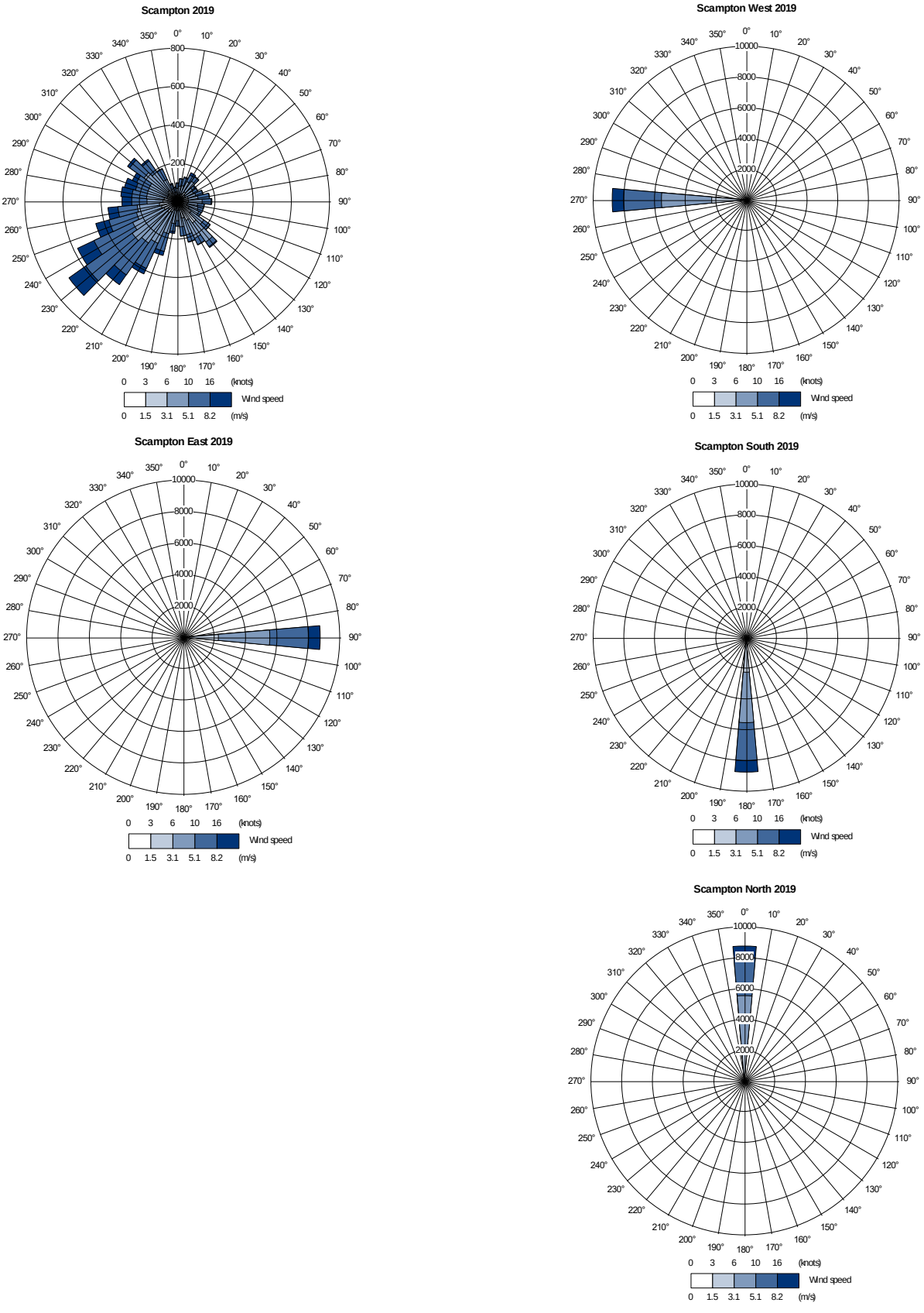
6.6 BUILDINGS IN THE MODELLING ASSESSMENT

Buildings nearby or immediately adjacent to the fire location could potentially cause building downwash effects on emission sources. There would be no large buildings located adjacent to the solar panels and therefore, no buildings have been included in the model for the assessment.

6.7 TREATMENT OF TERRAIN

The presence of steep terrain can influence the dispersion of emissions and the resulting pollutant concentrations. USEPA guidance indicates that terrain effects should be considered if the gradient exceeds 1:10. As the land is relatively flat, digital terrain data have not been used in the assessment.

Figure 6-1. Meteorological Station Wind Rose



6.8 MODELLING UNCERTAINTY

Uncertainty in dispersion modelling predictions can be associated with a variety of factors, including:

- Model uncertainty - due to model limitations;
- Data uncertainty - including emissions estimates, background estimates and meteorology; and,
- Variability - randomness of measurements used.

However, potential uncertainties in model results have been minimised as far as practicable and worst-case inputs considered in order to provide a robust assessment. This includes the following:

- Choice of model – ADMS-Road is a commonly used atmospheric dispersion model and results have been verified through a number of studies to ensure predictions are as accurate as possible;
- Emission rates - Emissions were based on the number of solar panels could be on fire at a time;
- Background concentrations - Background pollutant concentrations were obtained from a number of recognised sources in order to consider baseline levels in the vicinity of the site, as detailed within the main report text; and,
- Variability - All model inputs are as accurate as possible and worst-case conditions have been considered where necessary in order to ensure a robust assessment of potential pollutant concentrations.

7.0 DETAILED MODELLING ASSESSMENT RESULTS

The detailed computational modelling assessment of process emissions of particulate matter ($PM_{2.5}$) was undertaken using the input parameters detailed in Section 6.

Predicted $PM_{2.5}$ concentrations have been used to determine the air quality category levels of the health concern.

Short-Term (1-hr mean) Particulate Matter ($PM_{2.5}$)

The short-term emissions of particulate matter ($PM_{2.5}$) from a fire incident were assessed using the adjusted met data which assumes the wind would blow constantly in one direction during the fire, resulting in the worst impact on the receptors at downwind locations. A total of 4 wind directions of easterly, westerly, southerly and northerly winds have been assessed.

The model results show that the maximum predicted particulate matter concentration at the modelled receptor locations was predicted when wind is blowing from the north. The model results also demonstrate that there is very little difference (less than 0.01% of differences) between the predicted concentrations when using the east, south or west wind met data. The predicted concentrations when wind is blowing from the north, are presented in **Table 7-1** for the assessment.

Table 7-1. The Short-Term (1-Hour Mean) Concentrations of $PM_{2.5}$ at Different Receptor Locations

Receptors at Down Wind Locations of a Fire		The Maximum Predicted 1-Hour Mean (µg/m^3)	
Name	Wind Blows from North to South	PC [a] (µg/m^3)	PEC [b] (PC + Background [c]) (µg/m^3)
10 m from the Fire	S1	588.71	603.1
20 m from the fire	S2	244.20	258.6
30 m from the Fire	S3	155.77	170.2
40 m from the Fire	S4	116.55	130.9
50 m from the Fire	S5	94.15	108.5
60 m from the Fire	S6	79.45	93.8
70 m from the Fire	S7	68.98	83.4
80 m from the Fire	S8	61.06	75.4
90 m from the Fire	S9	54.84	69.2
100 m from the Fire	S10	49.80	64.2
110 m from the Fire	S11	45.62	60.0
120 m from the Fire	S12	42.11	56.5
130 m from the Fire	S13	39.09	53.5
140 m from the Fire	S14	36.48	50.9
150 m from the Fire	S15	34.18	48.6
160 m from the Fire	S16	32.15	46.5
170 m from the Fire	S17	30.34	44.7
180 m from the Fire	S18	28.72	43.1
190 m from the Fire	S19	27.25	41.6
200 m from the Fire	S20	25.92	40.3

Note:
(a) PC – the process contribution/the concentration contributed by fire;
(b) PEC the predicted environmental concentration (PC + background); and
(c) 1-hour $PM_{2.5}$ background concentration of 14.39µg/m^3.

The $PM_{2.5}$ concentrations determined in **Table 7-1** have been combined with the smoke levels from particulate matter concentrations shown in **Table 4-1** to determine the air quality category at each of the receptor locations, as shown in **Table 7-2**.

Table 7-2. Predicted $PM_{2.5}$ Concentrations and Associated Air Quality Category

Receptors at Down Wind Locations of a Fire		The Maximum Predicted 1-Hour Mean ($\mu g/m^3$)	Air Quality Category
Name	Wind Blows from North to South	PEC (PC + Background) ($\mu g/m^3$)	
10 m from the Fire	S1	603.1	Hazardous
20 m from the fire	S2	258.6	Unhealthy
30 m from the Fire	S3	170.2	Moderate/Unhealthy for Sensitive Groups
40 m from the Fire	S4	130.9	
50 m from the Fire	S5	108.5	
60 m from the Fire	S6	93.8	
70 m from the Fire	S7	83.4	
80 m from the Fire	S8	75.4	
90 m from the Fire	S9	69.2	
100 m from the Fire	S10	64.2	
110 m from the Fire	S11	60.0	
120 m from the Fire	S12	56.5	
130 m from the Fire	S13	53.5	
140 m from the Fire	S14	50.9	
150 m from the Fire	S15	48.6	
160 m from the Fire	S16	46.5	
170 m from the Fire	S17	44.7	
180 m from the Fire	S18	43.1	
190 m from the Fire	S19	41.6	
200 m from the Fire	S20	40.3	
>200 m from the Fire	-	<40	Good

Table 7-3, below, details 4 identified air quality category zones.

Table 7-3. Air Quality Category Zones

Air Quality Category Zones	Distance to a Fire (m)
Hazardous Zone	Within 10 m from the fire
Unhealthy Zone	11 to 20 m from the fire
Moderate/Unhealthy for Sensitive Groups Zone	21 to 200 m from the fire
Good Air Quality Zone	More than 200 m from fire

8.0 ACTION PLAN FOR PROTECTING HUMAN HEALTH FROM FIRE SMOKE

The following table details actions to be taken for the protection of human health during a fire within the identified air quality category zones.

Table 8-1. Recommended Actions in Case of a Fire

Air Quality Category	Air Quality Category Zones	Health Messages At-Risk (Sensitive*) Populations	Health Messages General Populations	Actions for Site Manager/fire safety representative at Island Green Power Limited
>200 metres from a fire	Good Air Quality Zone	Enjoy your usual outdoor activities	Ideal air quality for outdoor activities	N/A
21 - 200 metres from a fire	Moderate/Unhealthy for Sensitive Groups Zone	Reduce or reschedule prolonged strenuous activities and limit time spent outdoors	Be aware of health effects of smoke and related symptoms.	Inform any residents/public within the zone. Advise public about: health effects of smoke, related symptoms, and ways to reduce exposure. If the smoke event is projected to be prolonged, evaluate and notify possible cleaner air area and prepare evacuation plans for At-Risk Populations.
21 – 20 metres from a fire	**Unhealthy Zone**	Avoid prolonged strenuous activities and stay indoors if possible.	Reduce or reschedule prolonged strenuous activities outdoors, especially if you experience symptoms.	Inform any residents/public within the zone and Consider having populations go to cleaner air area.
10 m metres from a fire	**Hazardous Zone**	Avoid all strenuous activities and stay indoors.	Avoid all strenuous activities and stay indoors.	Inform any residents/public within the zone to cancel outdoor events. Consider having populations go to cleaner air area.

*Note: *Sensitive: People with existing respiratory and cardiovascular conditions, infants and young children, the elderly, pregnant women and possibly other groups (diabetics, smokers and people participating in sports or strenuous work outdoors).*

9.0 AIR QUALITY ASSESSMENT OF EMISSIONS IMPACT FROM BATTERY ENERGY STORAGE SYSTEMS (BESS) FIRE

9.1 NATIONAL OPERATIONAL GUIDANCE: CONTROL MEASURE – CORDON CONTROL: HAZARDOUS MATERIALS

The 'National Operational Guidance: Control measure – Cordon controls: Hazardous materials' guidance is developed and maintained by the National Fire Chiefs Council (NFCC). The guidance provides emergency action codes in case of a fire which releases gases, vapours or dust.

The guidance can be downloaded on: [redacted]

The emergency action codes states the following:

> *"The Dangerous Goods Emergency Action Code List (EAC) gives the following information on public safety hazards. An 'E' following the first two characters of an EAC indicates that there may be a public safety hazard outside the immediate area of the incident, and that the following actions should be considered by first responders:*
>
> - *People should be told to stay indoors, with all doors and windows closed, preferably in upstairs rooms facing away from the incident. They should eliminate all ignition sources and stop any ventilation*
> - *Effects may spread beyond the immediate vicinity. All non-essential personnel should be instructed to move at least 250m away from the incident*
> - *Police and fire and rescue service incident commanders should consult with each other and with a product expert or a source of product expertise*
> - *The possible need for subsequent public evacuation should be considered, but it should be remembered that in most cases it will be safer to shelter-in-place than to evacuate".*

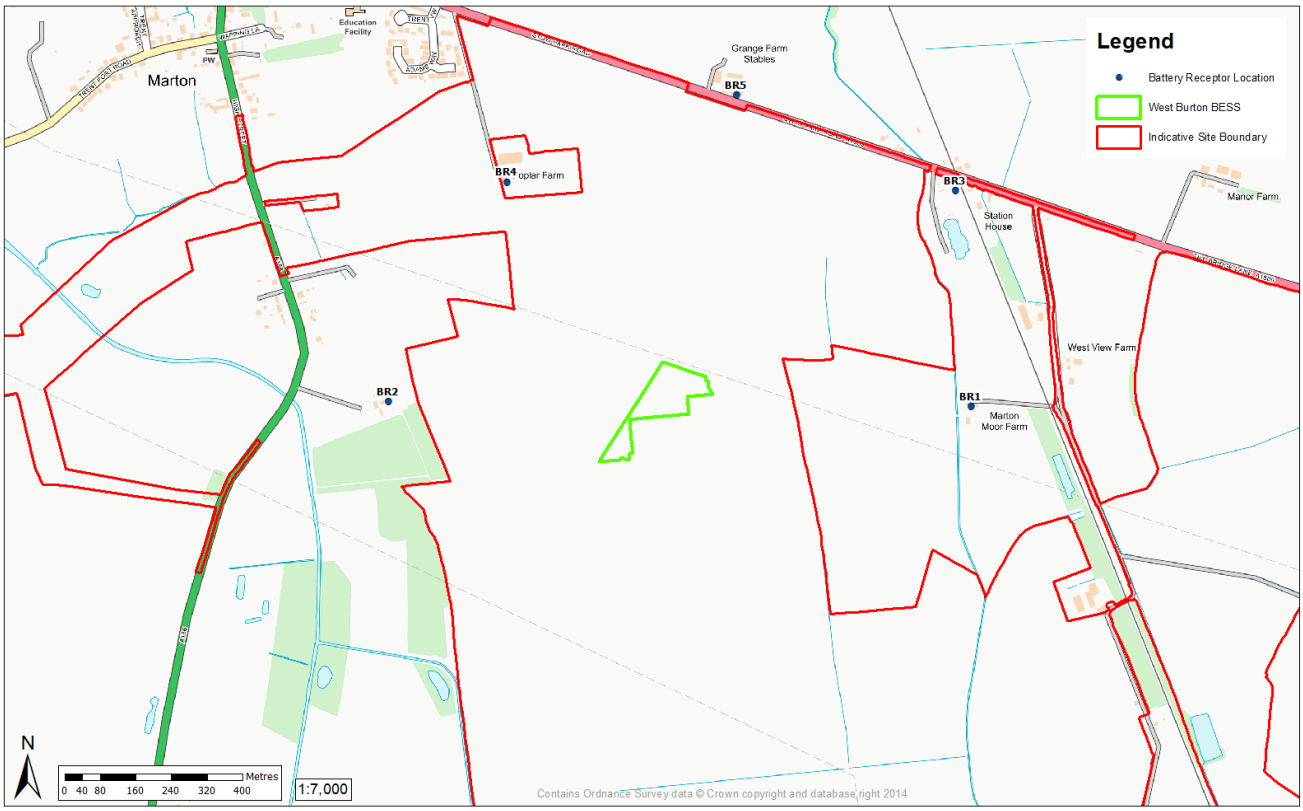
A key piece of information from the guidance which is used in considering the level of risk from a BESS fire at the proposed development states that '*All non-essential personnel should be instructed to move at least 250m away from the incident*'. This guidance will be used to help determine the potential effects of a BESS fire for the purposes of this technical note.

9.2 RECEPTORS FOR THE BESS FIRE EMISSION IMPACT ASSESSMENT

The receptor locations relevant to the BESS are shown in Figure 1 1.

The closest sensitive receptor is approximately 490 m from the BESS boundary.

Figure 9-1. Receptor Locations



9.3 BESS FIRE EMISSION IMPACT ON SURROUNDING SENSITIVE RECEPTORS

The consideration factors used to determine the potential impact of a BESS fire incident at the proposed development are as follows:

1) The closest residential receptors are located more than 490 m away from the BESS boundary;
2) A BESS fire would only produce a short-term impact in terms of surrounding environment;
3) The National Fire Chiefs Council states that the effects (in case of a fire) may spread beyond the immediate vicinity and that all non-essential personnel should be instructed to move at least 250m away from the incident; and
4) Tetra Tech's fire accident impact assessment on a solar panel fire concludes that a receptor that is located > 200 m from a fire would be in a good 'air quality category zone'.

Based on the factors of distance to the nearest property, the short-term nature of a fire incident, guidance from the NFCC, and this fire accident impact assessment, it is concluded that there will not be adverse effects at the closest receptor locations as a result of a BESS fire incident at the proposed development, and therefore, detailed modelling and assessment of a BESS fire plume is not required.

Whilst there is low risk of adverse effects at the closest receptors, in the case of a BESS fire at the proposed development, good practice safety measures will be implemented in accordance with the action plan presented in this report. These measures include the following:

"The site manager/fire safety representative will need to assess the fire locations, wind directions and surrounding receptors. The site manager/fire safety representative will take appropriate actions accordingly. The actions to be taken include:

1) *to inform any potentially affected residents within the affected zones and to advise public about health effects of smoke, related symptoms, and ways to reduce exposure;*
2) *to cancel outdoor events; and/or*
3) *to move affected residents to a cleaner air location."*

10.0 CONCLUSIONS

Tetra Tech Limited have undertaken a potential air quality impact assessment from a fire incident in support of a planning application for both Cottam Solar Project and West Burton Solar Project (the 'Scheme').

The effect of a fire incident has been assessed using the 'Air Quality Category' which is classified as 'good', 'moderate', 'unhealthy', 'very unhealthy' or 'hazardous'. The 'Air Quality Category' and air quality category zones have been defined according to the fire-generated particulate matter (equivalent to $PM_{2.5}$) concentrations in air.

Four air quality category zones have been identified:

- Hazardous Zone – within 10 metres from a fire;
- Unhealthy Zone – 11 to 20 metres from a fire;
- Moderate/Unhealthy for Sensitive Groups Zone – 21 to 200 metres from a fire; and
- Good Air Quality Zone – more than 200 metres from a fire.

A fire could occur at any location within the development during the site construction, operational and decommissioning phases, therefore, generic receptor locations have been used in the assessment. In the case of a fire occurring, the site manager/fire safety representative will need to assess the fire locations, wind directions and surrounding receptors. The site manager/fire safety representative will take appropriate actions accordingly. The actions to be taken include (1) to inform any potentially affected residents within the affected zones and to advise public about health effects of smoke, related symptoms, and ways to reduce exposure; (2) to cancel outdoor events; and/or (3) to move affected residents to a cleaner air location.

UNITS AND ABBREVIATIONS USED

ADMS	Advanced distribution management system
ASR	Annual Status Report
AQAP	Air Quality Action Plan
AQO	Air Quality Objectives
AQMA	Air Quality Management Area
CHP	Combined Heat and Power
CLJSPC	Central Lincolnshire Joint Strategic Planning Committee
DEFRA	Department for Environment, Food and Rural Affairs
DPD	Development Plan Document
EA	Environment Agency
EAL	Environmental Assessment Level
EC	European Commission
EPAQS	Expert Panel on Air Quality Standards
EPUK	Environmental Protection UK
ES	Environment Statement
EU	European Union
g/s	Gram per second
°C	Temperature (in Celsius)
IAQM	Institute of Air Quality Management
LA	Local Authority
LAQM	Local Air Quality Management
MHCLG	The Ministry for Housing, Communities and Local Government
m/s	Velocity (in metres per second)
$\mu g/m^3$	Concentration (in micrograms per cubic metre)
m^3/s	Volumetric flow rate (in cubic meters of air per second)
mg/Nm^3	Concentration (in milligrams per cubic metre at standard conditions)
mg/s	Emission rate (in milligrams per second)
MW	Megawatts
UK NGR	UK National Grid Reference
NO_2	Nitrogen dioxide
NO_X	Total oxides of nitrogen
NPPF	National Planning Policy Framework
PAHs	Polycyclic Aromatic Hydrocarbons
PC	Process contribution
PEC	Predicted environmental concentration
PM	Particulate Matter
PM_{10}	Particulate matter with a mean hydraulic diameter less then 10µm
$PM_{2.5}$	Particulate matter with a mean hydraulic diameter less then 2.5µm
PPG	Planning Policy Guidance
PPS	Planning Policy Statements
PV	Photovoltaic
%ile	Percentile
%(v/v)	Percentage (volume per volume)
TETRA TECH	Tetra Tech Limited
USEPA	United States Environmental Protection Agency
WHO	World Health Organization

APPENDIX A - REPORT TERMS & CONDITIONS

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