Gate Burton Energy Park Environmental Statement

Volume 3, Appendix 15-C: Unplanned Atmospheric Emissions from Battery Energy Storage Systems (BESS)
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1. Introduction

1.1 Purpose of this Report

1.1.1 The report considers the potential consequences of unplanned emissions to air from the use of battery technology within Gate Burton Energy Park.

1.1.2 The scope of this study includes:

- A review of potential emissions to air from out-gassing and from fire;
- Consideration of the potential magnitude of emissions;
- Consideration of likely rates of dilution between potential emission locations and sensitive receptors located outside the Order limits; and
- Consideration of the likely consequences of emissions to air from the Battery Energy Storage Systems (BESS).

1.2 Background

1.2.1 Battery technologies are used at renewable energy generation facilities to store electrical power so it can be supplied to the national grid when it is most needed. In the case of a solar farm this may be during the hours of darkness, for example.

1.2.2 The BESS on the Solar and Energy Storage Park will consist of a compound and battery array with a peak output of 531 MW. Details of the design for the BESS elements, including their power and energy ratings, and their final enclosure dimensions and appearance, are currently in development and, therefore, the assessment has been based on maximum parameters which would not be exceeded (as set out in **ES Volume 1, Chapter 2: The Scheme [EN010131/APP/3.1]**), the **Outline Design Principles [EN010131/APP/2.3]**, and the **Outline Battery Safety Management Plan [EN010131/APP/7.1]** secured by a Requirement of the DCO). At this stage it is known that:

- BESS enclosures will be separated from each other by a dedicated separation distance, which is currently a minimum of ~3 m for the concept design.
- The separation distance between the battery enclosures and Order limits boundary will be in accordance with NFPA 855 which is currently a minimum of 20 m in the concept design. This far exceeds the current NFPA guidance of 3 m.
- The areas between and around equipment will be finished with gravel and kept free of vegetation or other material that could act to spread a fire.
- Each battery enclosure will be a single storey of approximately 4.5 m
- Included within the design, each enclosure will have:
  - Thermal monitoring of the battery enclosures and automated cut-out beyond safe parameters.
  - Battery liquid cooling systems with automated fail safe operation.
  - Emergency Stop – both remote and local.

- o Fire and vapour cloud (immediate and delayed ignition) detection suitable to the architecture.
- o Standard heat detection system.
- o Electrical fire suppression equipment

1.3 Site Description

1.3.1 The site is described in detail in **ES Volume 1, Chapter 2: The Scheme [EN010131/APP/3.1]**. The site is in a rural area, with few residential properties. Figures 2-4 show the results of the dilution modelling undertaken in this assessment in the context of the local area.

2. Emissions from Incident Fires

2.1 Potential Sources of Emissions to Air

2.1.1 The battery technology for the Scheme has not been confirmed yet but is likely to be based on lithium-ion, as these are the most widely used in BESS at this time.

2.1.2 If the battery cells become damaged by heat or are burnt within a fire affecting a single module, a rack of modules or multiple racks, then the combustible materials consumed in the fire could give rise to a range of organic and inorganic air pollutants. This situation is true of any incident fire and sets of emission factors have been collated by the Environment Agency (Ref 2) for incident fires involving automobiles, buildings, and waste materials, for example. A standardised set of emission factors for BESS is not currently available from the Environment Agency and, therefore, equivalent data must be sourced from manufacturers and the research literature.

2.1.3 In 2016 a U.S. based organisation, The Fire Protection Research Foundation (FPRF), published a report (Ref 3) on 'Hazard Assessment of Lithium-Ion Battery Energy Storage Systems' that included gas sample measurements from batteries subjected to external and internal ignition tests for BESS up to 100 kWh size. While the total BESS size at Gate Burton Energy Park is likely to be greater than 100 kWh, the modular nature of BESS means useful lessons can be learnt from studies undertaken using a BESS that is not the same size as is proposed for the Gate Burton Energy Park. The gases were measured near the tested unit, and included methane (chemical formulae CH_4), chlorine (chemical formulae Cl_2), hydrogen fluoride (chemical formulae HF) and carbon monoxide (chemical formulae CO).

2.1.4 The battery pack utilised in the FPRF test was a 100 kWh unit manufactured by Tesla Energy (Tesla) meant for commercial applications (Powerpack). The Powerpack consists of a 52-inch long by 38-inch wide by 86-inch tall steel cabinet containing the battery, protection electronics, and thermal management systems.

2.1.5 The observations from the FPRF tests included:

- The 100 kWh Powerpack cabinet was located outdoors for the test, and with no fire suppressant system in operation was on fire for 3.7 hours until it had burnt out;
- A maximum concentration of 50 parts per million (ppm) of carbon monoxide (CO) was detected in the first 30 minutes of the test and this decreased to near zero during the main period of self-sustaining combustion, which is not unexpected for a fire occurring outdoors;
- Chlorine and methane were not detected (<1 ppm) during the test; and
- Hydrogen fluoride (HF) was detected at concentrations > 100 ppm (i.e., over range for the detector used) after 30 minutes and then for the duration of the fire.

2.1.6 From the FPRF study the emissions of potential concern are considered to be HF and CO. The conclusion that HF emissions occur is supported by the small-scale laboratory trials undertaken by Anderson et al. at the SP Technical Research Institute of Sweden (Ref 4).

2.1.7 Although Anderson et al.'s study used small 26650 type cells, laptop battery packs (including housings) or extracts of electrolytes, rather than it being a BESS scale study, it also had access to monitoring equipment that was capable of more precise measurements over a larger concentration range. The observations from Anderson et al. included:

- HF was always detected in combustion tests;
- Concentrations of HF in the exhaust duct of the test apparatus were managed by the operator to enable concentrations of between 30 ppm and 50 ppm to be reported, as this aided the study of the relative comparison of hydrogen fluoride and other pollutant abundance. Consequently, the reported concentrations of hydrogen fluoride that are presented as ppm values in this study are not representative of HF concentrations near to source, as the volume of air passing through the duct and the resulting dilution rate is unknown;
- Cells burnt when at 100% SOC (state of charge) produced less HF than cells at 50% SOC; and
- Anderson provides an example of scaling the cell test results up to represent a plug-in hybrid vehicle (PHEV) containing 432 similar cells, that could potentially emit a total of between 400g and 1200 g of HF if combusted. The lower value being for cells at 100% SOC.

2.1.8 Some information is publicly available on HF content of BESS rack systems from the Cleve Hill Development Consent Order application (Ref 5). Several key arguments were presented and accepted for the Cleve Hill DCO and it is reasonable to flag that these arguments were tested and accepted through the Cleve Hill DCO process, therefore a similar approach can and should be taken for Gate Burton.

2.1.9 The Leclanche SA assessment, which was relied upon in the Cleve Hill examination, set out that in the case of a fire with no fire suppression system, it is likely that only 5 racks would be burning at any one time. This means that the whole size of the development is not relevant, as the time taken for the fire to spread means that only 5 racks will be alight at any one time. This principle is directly transferable to Gate Burton or any other BESS site.

2.1.10 As racks are equipped with fire suppression measures, there would be a delay in heat transfer between racks in the event of a fire and it is likely that the first modules or racks to catch fire would burn out before racks further away within the enclosure would catch fire, assuming no operational fire suppressant system. It should be noted that Gate Burton BESS has internal cooling, fire suppression and fire protection as part of the design. A conservative approach of assuming a maximum of 5 racks with a self-sustaining fire at one time was assumed by manufacturer LeClanche SA (Ref 5) with a total HF content of 2.07 kg within 5 racks.. The assumption relates specifically to the estimation of the rate of emission within a single hour. It may be that a fire would last for many hours but during those hours the emissions would be less than for the hour with the maximum emissions. Therefore this approach is inherently conservative.

2.1.11 The 5 rack scenario represents a situation in which a fire is underway in 1 rack, the fire is just starting in 2 racks, and is burning out in 2 racks. However for all 5 racks the maximum emission has been assumed even though for some of the racks, the emission will have already occurred in the past.

2.1.12 This approach suitably represents a scenario with a fire within a single enclosure

2.1.13 CO will be produced especially during venting reactions. However, UL 2021 report demonstrates that the risk is only in close proximity to BESS (<4-5 metres). The focus of the Unplanned Emissions Report is on impacts beyond the site boundary and at those distances, CO is not of concern.

2.1.14 In summary, only emissions of HF are likely to occur at concentrations that may pose a hazard to health at off-site receptor locations and assessment criteria for the protection of public health are considered in section 2.2. Emissions of methane and chlorine are not considered further in this report, as they are unlikely to be emitted at measurable concentrations and therefore could not cause elevated concentrations at any receptor location. While concentrations of CO at the source may be elevated, concentrations rapidly decrease, and a fire would not cause elevated concentrations at any receptor location.

2.1.15 This analysis is limited to a reasonable worst-case event. A catastrophic event, such as an airplane impact, run-away vehicle impact, terrorist incident or nearby construction equipment collapse causing impact, could cause multiple racks/enclosures to be destroyed, causing substantial emissions associated with a large-scale fire. A reasonable worst-case event is more limited in scope, defined as a control system failure or a puncture of a module, similar to that conducted as part of the UL 1973 testing, which could cause a runaway reaction in a group of cells. Generally, a reasonable worst-case scenario is more appropriate for a planning scenario as any development project could produce substantial fires and cause impacts to neighbouring facilities under the catastrophic scenario.

2.2 Assessment Criteria

2.2.1 The UK Health Security Agency (UKHSA) (formerly Public Health England (PHE)) publish Incident Management guidance for specific air pollutants including hydrogen fluoride (Ref 6). These documents summarise the physical and chemical properties of the substance and the hazard they pose to human health. Internationally recognised best practice emergency response guidelines are reported by UKHSA.

2.2.2 Emergency response planning guideline (ERPG) values start at ERPG-1 and increase in concentration up to ERPG-3. The ERPG-1 criteria define "the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects".

2.2.3 Acute exposure guideline level (AEGL) values start at AEGL-1 and increase in severity of health outcome to AEGL-3. The AEGL-1 criteria define the "level of the chemical in air or above which the general population could experience notable discomfort".

2.2.4 The values adopted as being most protective of receptors (or the most conservative in terms of likely impacts on receptors) surrounding the solar farm are listed in Table 1. Concentrations of 1 ppm and 2 ppm of HF gas are equivalent to 0.82 milligrams per cubic meter (mg/m^3) and 1.64 mg/m^3 respectively. The time periods used for ERPG and AEGL are based on different considerations, but for the purposes of this assessment they represent a maximum concentration value in a 10-minute period. These concentration values are also valid at an averaging time of 1 hour, which is the resolution of the meteorological data used in this assessment.

Table 1 Summary of Emergency Response Criteria

Substance	ERPG-1 Value (ppm)	Time Period for ERPG	AEGL-1 (ppm)	Time Period for AEGL
HF	2	10 minutes & up to 1 hour	1	10 minutes & up to 8 hours)

3. Dispersion and Dilution

3.1 Introduction

3.1.1 Any gaseous pollutants emitted from a fire at a BESS would be transported from the BESS towards receptor locations by the air movements occurring at the time of the emission to air. These movements are determined by the direction of the wind and also the amount of turbulent mixing of the air as it blows towards the receptor location. Differences in the temperature of the plume of air containing the emission and the surrounding air can also affect the vertical movement of the pollutants. To help understand the minimum rates of dilution likely to occur to pollutant concentrations as they disperse from the source of the emission to receptor locations, the dispersion has been modelled.

3.1.2 The calculations have made use of the dispersion model ADMS (version 5.2.4.0). As a definitive emission rate will not be known until later in the detailed design stage (once battery technology and the number of modules, racks and enclosures is fixed), the dispersion model has not been used to predict absolute impacts at specific receptor locations. Instead, a nominal unit emission rate has been used to calculate concentrations close to the source and at fixed nodes that are at 50 m increments downwind, for all wind directions in 10-degree segments. The relative concentration at the nodes is expressed as the amount of dilution compared to the near source concentration. This is then displayed as a colour scale on a polar plot overlaid onto base mapping.

3.1.3 The dispersion modelling has been undertaken using 5 years of hourly sequential meteorological data to represent approx. 43,800 sets of meteorological conditions that have been observed at a representative meteorological station. The values reported represent the minimum amount of dilution (maximum concentration at the receptor) predicted in any 1-hour period (100th percentile). In addition, the 99th percentile (upper 1% of cases) and 90th percentile (upper 10% of cases) values have also been calculated to provide context to the likelihood of each outcome. If the magnitude of the maximum (100th percentile) concentration was very similar to the 99th or 90th percentile value, then the likelihood of those meteorological conditions being present at the time of the fire is high. If the 100th percentile concentration value is much larger in magnitude than the 99th or 90th percentile values, then the predicted concentration would only occur under meteorological conditions that are very unusual and that may only occur for a small number of hours per year.

3.2 Emission Parameters

3.2.1 As the exact emissions from the BESS cannot be meaningfully estimated at present, the modelling is based on emissions that have been modelled as a volume source, at a nominal emission rate of 1 $\mu g/m^3/s$.

3.2.2 A number of simplifications have been made to the model to ensure the assessment approach is precautionary and provides an upper estimate of likely outcomes. Near source temperatures in excess of 300 °C can be reasonably expected to be present, which would result in the plume rising rapidly, reducing near-ground concentrations. However, this model has assumed a volume source with no initial vertical momentum and the temperature has been modelled as if it was emitted at ambient air temperature. These two assumptions represent a very conservative approach in terms of dispersion modelling as they remove the vertical momentum of the emission and consequently the predicted near ground level concentrations from the model are considerably higher than would be experienced under real world conditions, as the plume has been modelled without that initial vertical momentum caused by the fire.

3.2.3 The emission parameters modelled are summarised in Table 2, and they are discussed in the following sections.

Table 2 Emission Parameters and General Model Conditions Included with the Model

Variable	Input
Surface Roughness at source	0.5 m
Receptors	Polar grid centred at location of source. Nodes at 50 m intervals, segments at 10 degrees intervals.
Emissions	Indicative scenario at unit emission rate
Sources	A single volume source 2 m (length) by 2 m (width)
Volume Source Vertical Height	2 m, located between 1 m and 3 m above ground
Emission Temperature	Ambient (15 °C)

Variable	Input
Exit Velocity	None
Emission Rate	1 µg/m^3/s
Source Location	Indicative location within plot for each BESS
Meteorological data	5 years of hourly sequential data from Doncaster Sheffield meteorological station (2017 – 2021)

3.3 Modelling Domain

3.3.1 The model outputs are at nodes on a polar coordinate grid extending 1.5 km from the source (i.e. 1.5 km radius circle) with grid nodes at 50 m intervals along each of the 36 segments (one every 10 degrees).

3.4 Meteorology

3.4.1 The dispersion of emissions from a point source is largely dependent on atmospheric stability and turbulent mixing in the atmosphere, which in turn are dependent on wind speed and direction, ambient temperature, cloud cover and the friction created by buildings and local terrain.

3.4.2 Actual observed hourly sequential meteorological data is available for input into dispersion models, and it is important to select data as representative as possible for the site that is modelled. This is usually achieved by selecting a meteorological station as close to the site as possible, although other stations may be used if the local terrain and conditions vary considerably, or if the station does not provide sufficient data. For point sources, such as stacks, the Environment Agency recommends the use of five years of the recent available meteorological data be used in modelling assessments to ensure that all typical weather conditions are considered within the modelling.

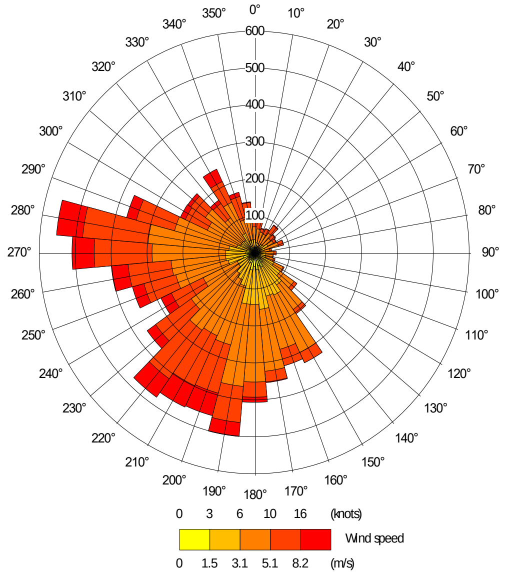
3.4.3 The meteorological site used in the modelling was Doncaster Sheffield Airport for the years 2017 – 2021 (World Meteorological Office station 3405.4). The meteorological site is located between 20 and 25 km north-west of the Scheme, and is the closest WMO station to the site. The meteorological conditions at the airport are considered representative of those experienced at the site.

3.4.4 The wind-roses for Doncaster Sheffield Airport meteorological data are shown in Figure 1.

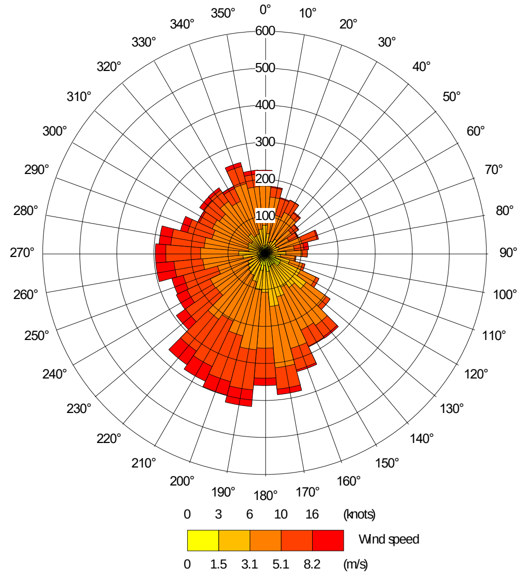
Figure 1 Wind-Roses for Doncaster Sheffield Airport

Wind-roses for Doncaster Sheffield Airport

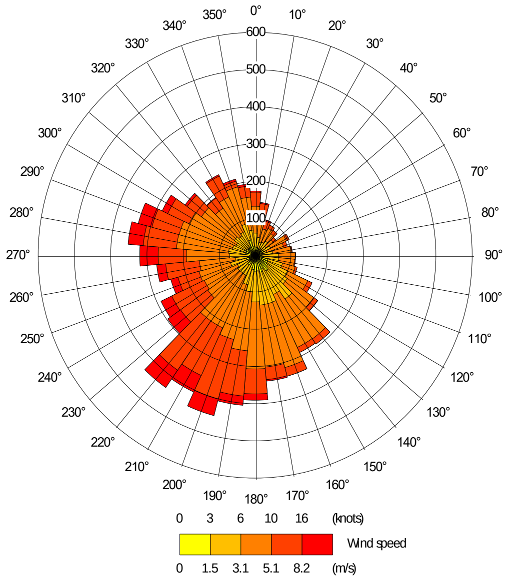
2017



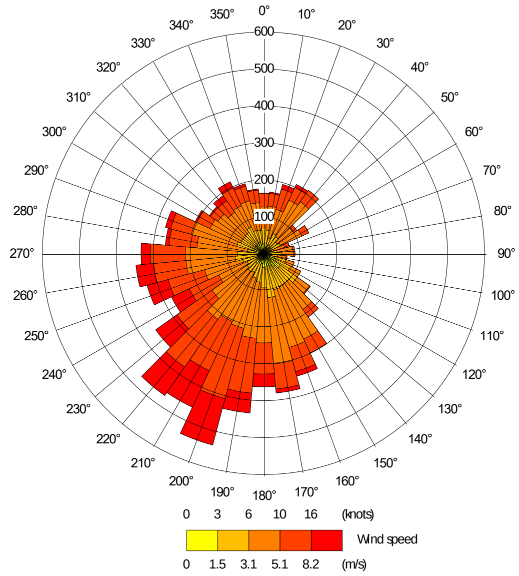
2018



2019

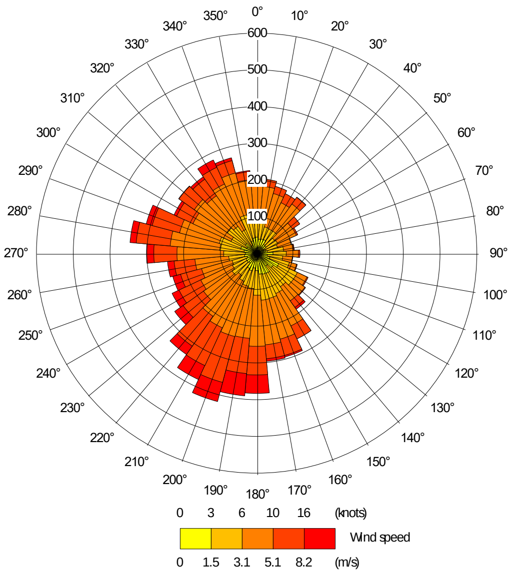


2020

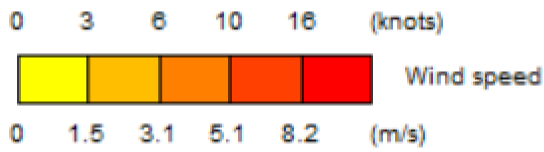


Wind-roses for Doncaster Sheffield Airport

2021



Legend



3.5 Building and Terrain Effects

3.5.1 Another variable that can have a significant effect on the dispersion of emissions from sources is the presence of buildings or structures near to the emissions points. The wind field can become entrained into the wake of buildings, which causes the wind to be directed to ground level more rapidly than in the absence of a building. If an emission is entrained into this deviated wind field, this can give rise to elevated near-field ground-level concentrations. Building effects are typically considered where a structure of height greater than 40% of the release height, is situated within a distance that is less than 10 times the release height of the emissions source. Neighbouring enclosures could potentially fit these criteria. To assess dispersion of emissions in a conservative manner, the potential influence of buildings has not been considered in the assessment, along with the use of a ground level volume source with air at ambient temperature and no initial vertical momentum.

3.5.2 The ADMS model is capable of including topographical data, if required. There are two parameters (surface roughness and terrain) which can be employed in the model to describe local topography.

3.5.3 Surface roughness describes the degree of ground turbulence caused by the passage of winds across surface structures. Ground turbulence is greater in urban areas than in rural areas, for example, due to the presence of tall buildings.

3.5.4 The Scheme is situated on a plain adjacent mostly to agricultural land and surrounded by a few towns and villages. A surface roughness of 0.5 m, corresponding to parkland and open suburbia has been selected to represent the local terrain.

3.5.5 Site-specific terrain data has not been used in the model, as typically terrain data will only have a marked effect on predicted concentrations where hills with gradient of more than 1 in 10 are present in the vicinity of the source, which is not the case at this site.

3.6 Results of Dilution Modelling

3.6.1 The conventional output from a consequence model would be a plot illustrating a series of rings denoting a maximum concentration at a stated distance from the source. The output from the dilution modelling is similar with the plots showing rings of nodes at 50 m increments from the source, with the dilution factor illustrated using a colour scale. The reported dilution factors are relative to the concentration at a location 10 m out from the centre of the source.

3.6.2 Table 3 illustrates the smallest rate of dilution likely to be experienced under any meteorological conditions (the 100th percentile), Table 3 also illustrates a dilution rate that would be achieved under 99% (8672 out of 8760 hrs per year) of meteorological conditions and a dilution rate that would be achieved under 90% (7884 out of 8760 hours per year) of meteorological conditions. In real world terms, these represent the lowest level of dilution and longest distances to achieve that level for the stated percentage of the year.

3.6.3 Results indicate that source concentrations would be diluted to 1/1000th of the source concentration (a dilution factor of 0.001) within 1000 m under any meteorological conditions (the 100th percentile) likely to occur at the application site. The same level of dilution is likely to occur under 99% of meteorological conditions within 700 m to the southeast of the source.

3.6.4 Source concentrations would be diluted to 1/1000th of the source concentration (a dilution factor of 0.001) under 90% of the meteorological conditions likely to occur at the application Sites (see Table 3), within 150 m for all wind directions.

3.6.5 For any emission rate at the source, the use of the minimum (100th percentile) dilution rate gives an estimate of dilution rates that is approximately seven times more precautionary that the use of the 90% value. As such it represents an extreme combination of meteorological conditions that are unlikely to occur should there be a fire incident.

Table 3 Dilution with distance from source

	Distance from source (m)		
Distance from Source	Dilution factor of 0.001 for 100% of meteorological conditions	Dilution factor of 0.001 for 99% of meteorological conditions	Dilution factor of 0.001 for 90% of meteorological conditions
0° N	950 m	550 m	150 m
50° NE	950 m	550 m	150 m
90° E	950 m	650 m	150 m

Distance from Source	Distance from source (m)		
	Dilution factor of 0.001 for 100% of meteorological conditions	Dilution factor of 0.001 for 99% of meteorological conditions	Dilution factor of 0.001 for 90% of meteorological conditions
130° SE	950 m	700 m	150 m
180° S	1000 m	500 m	100 m
230° SW	950 m	450 m	150 m
270° W	950 m	550 m	150 m
310° NW	950m	500m	150

*based on 2021 meteorological data as highest impact in period 2017-2021

4. Likely Consequences of Battery Emissions

4.1.1 At present the scale of the modules and numbers of racks has still to be confirmed for Gate Burton Energy Park. Based on information from section 2 of this Appendix, indicative scenarios to represent the potential emissions of HF are summarised in Table 4.

4.1.2 The central estimate of HF content that could be emitted has been taken as 2 kg which is rounded from the estimate published by LeClanche SA for the Cleve Hill Development Consent Order (DCO) (Ref 5). A lower estimate based on 50% of the central estimate and an upper estimate of 150% of the central estimate are included in Table 4 to reflect uncertainty about the SOC of the cells at the time of a fire incident (SOC effect observed by Anderson et al.).

4.1.3 The HF has been assumed to be released at a steady rate during a fire and a time period based on the FPRF BESS fire test of 3 hours has been adopted as the shorter time period. A longer 6-hour fire period has been adopted as a lower emission rate condition.

Table 4 Indicative Emission Rates

Scenario	HF content in 5 racks	Duration of Fire	Concentration in 2m x 2m x 2m volume at source	Dilution factor to achieve AEGL-1 value of 0.82 mg/m^3	Indicative distance to achieve AEGL-1 value for 100% of met conditions (m)
Lower HF_ shorter fire	1 kg	3 hrs	12 mg/m^3	0.068	50 - 100 m
Lower HF_ longer fire	1 kg	6 hrs	6 mg/m^3	0.136	<50 m

Scenario	HF content in 5 racks	Duration of Fire	Concentration in 2m x 2m x 2m volume at source	Dilution factor to achieve AEGL-1 value of 0.82 mg/m^3	Indicative distance to achieve AEGL-1 value for 100% of met conditions (m)
Central HF_ shorter fire	2 Kg	3 hrs	24 mg/m^3	0.034	100 - 150m
Central HF_ longer fire	2 Kg	6 hrs	12 mg/m^3	0.068	50 - 100 m
Upper HF_ shorter fire	3 Kg	3 hrs	36 mg/m^3	0.023	100 - 150m
Upper HF_ longer fire	3 Kg	6 hrs	18 mg/m^3	0.046	50 - 100 m

4.1.4 Assuming a BESS facility that takes the form of a 5-rack fire before fire control measures bring the fire under control, emissions of HF could cause concentrations over time periods of 10 minutes, 1 hour or up to 6 hours that are below the AEGL-1 value at locations further than 150 m of the fire, which is closer than the nearest sensitive receptors.

4.1.5 Given the specification reached in detailed design will be required (by a requirement to the DCO) to be consistent with the parameters assumed in the OBSMP, the assumptions made in this assessment are a worst case, as there will be mitigation measures to suppress fire which have not been accounted for in this study. As such the potential consequence exposure to HF at actual receptor locations surrounding the BESS would be below the AEGL-1 value.

4.1.6 The design of BESS includes a number of design elements to prevent, detect and control a fire should one occur. These include internal cooling, fire suppression and fire protection. The batteries will be controlled by charging management systems that will detect if a cell or battery is not operating correctly. The BESS will be fitted with a fire monitoring system with smoke, H_2 and CO_2 gas detectors, temperature monitoring and alarms so if one cell or module were to catch fire the fire suppression system will automatically be triggered to reduce the temperature and ensure that the burning cell/module does not affect the other cells/modules in the BESS.

4.1.7 Therefore, in the unlikely event that a fire was to break out in a single cell or module it is very unlikely, given the control measures, that the fire would spread to the rest of the BESS. Even should all the systems fail, and a large-scale fire break out within enclosures, then the resultant HF concentration at the closest receptors would be below the level that UKHSA has identified as resulting in notable discomfort to members of the general population.

4.1.8 The expected HF emissions will be checked against the assumptions in this report at detailed design stage once the make, model and layout of the BESS is known, and, if necessary, consequence modelling will be undertaken to demonstrate that the impacts associated with an unplanned fire would not exceed the effects outlined in this report or cause any significance adverse health effects to the local community.

5. References

Ref 1. NFPA 855 Standard for the Installation of Stationary Energy Storage Systems, 2020, National Fire Protection Association

Ref 2. Environment Agency, 2009, Review of emission factors for incident fires, Innovation for efficiency science programme, Science Report SC060037/SR3.

Ref 3. Fire Protection Research Foundation, 2016, Hazard Assessment of Lithium-Ion Battery Energy Storage Systems, Final Report.

Ref 4. Anderson et al. 2013, Investigation of Fire emissions from Li-ion batteries, Report SP 2013:15, SP Technical Research Institute of Sweden

Ref 5. LaChance SA, 2018, Cleve Hill Solar Park Air Quality Impact Assessment Li-ion Battery Fire, Appendix C.

Ref 6. Public Health England, 2021, Hydrogen Fluoride Incident Management

6. Glossary and Abbreviations

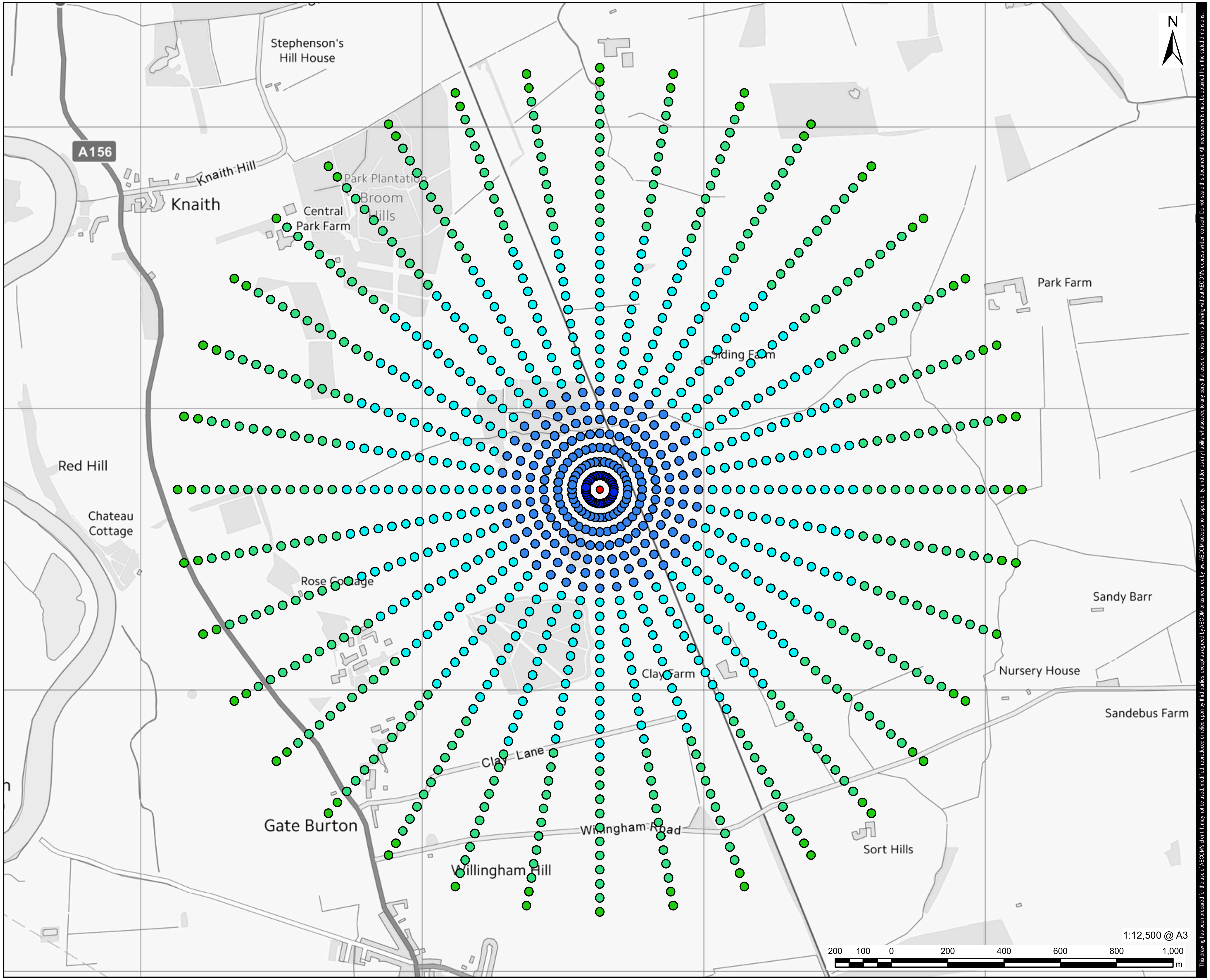
6.1 Glossary

Term	Meaning within this document
Battery	A generic term for a single cell or a group of cells connected together electrically in series, in parallel or a combination of both.
Battery Energy Storage System	Electrochemical cells (lead acid, Li-ion, solid state batteries, flow batteries, etc.) linked together with control systems and associated housings, to form a facility that can store chemical energy and deliver the stored energy in the form of electricity.
Cabinet	A form of enclosure where doors or hatches enable direct access to equipment but do not enable a person to enter the enclosure.
Cell	The basic electrochemical unit, characterised by an anode and a cathode, used to receive, store, and deliver electrical energy
Concentration	The total mass or volume of a substance per unit volume of air. Typically expressed as milligrams per cubic metre or as parts per million (ppm).
Container	A form of enclosure where a door and internal walkway enable a person to enter the enclosure to access equipment.
Enclosure	The structure used to house racks of batteries, typically in the form of a container or a cabinet.
Energy Capacity	The amount of energy stored within the BESS, typically expressed in terms of electrical energy using units of kilowatt hour (KWh).
Emission	A substance released into the atmosphere.
Li-ion cell	A rechargeable cell that uses lithium ions as the primary component of its electrolyte
Module	A self-contained unit made up of multiple cells, insultation, connections and a housing.
Node	A point within a dispersion model output grid, that a predicted value is reported for.
Off-gassing	Venting of electrolyte vapours from a cell.
Power Output	The aggregate net electrical energy that a Battery Energy Storage System can provide, typically expressed in units of megawatts (MW) or gigawatts (GW)
Rack	A structure used to hold a group of modules.
Receptor	A component of the natural or man-made environment that is affected by an impact, including people.
State of charge	The ratio of present dischargeable energy storage capacity to the maximum dischargeable energy storage capacity, typically expressed as a percentage value.
Thermal barrier	A physical measure to slow the rate at which heat transfers between two parts of a BESS, i.e. a thermal insulating material or the use of an air filled gap
Thermal runaway	The condition when an electrochemical cell increases its temperature through self-heating in an uncontrollable fashion and progresses when the cell’s heat generation is at a higher rate than it can dissipate, potentially leading to off-gassing or fire.

6.2 Abbreviations

Term	Term in Full
AEGL	Acute Exposure Guideline Level
BESS	Battery Energy Storage System
CH_4	Methane
CO	Carbon monoxide
DCO	Development Consent Order
ERPG	Emergency Response Planning Guideline
FPRF	Fire Protection Research Foundation
HF	Hydrogen fluoride
KWh	Kilowatt hour
MW	Megawatt
PHE	Public Health England
PHEV	Plug in hybrid electric vehicle
ppm	parts per million
SOC	State of charge
UKHSA	United Kingdom Health Security Agency

Annex A. Figure 2: Relative Dilution from Source Based on 100th %ile at Gate burton Energy Park BESS



AECOM

PROJECT

Gate Burton Energy Park

CLIENT

Gate Burton ENERGY PARK

CONSULTANT

AECOM Limited
Sunley House
4 Bedford Park
Surrey, CR0 2AP, UK
[redacted]

LEGEND

- Source

Relative Dilution Polar Plot

- ≤0.0005
- >0.0005 - ≤0.001
- >0.001 - ≤0.005
- >0.005 - ≤0.05
- ≤0.05 - 1.0

NOTES

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ISSUE PURPOSE

Environmental Statement

PROJECT NUMBER

60664324

FIGURE TITLE

Relative Dilution from Source Based on 100th %ile Value at Gate Burton Energy Park BESS

FIGURE NUMBER

Figure 2

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Annex B. Figure 3: Relative Dilution from Source Based on 99th %ile at Gate Burton Energy Park BESS

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PROJECT

Gate Burton Energy Park

CLIENT

Gate Burton ENERGY PARK

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Sunley House
4 Bedford Park
Surrey, CR0 2AP, UK
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LEGEND

- Source

Relative Dilution Polar Plot

- ≤0.0005
- >0.0005 - ≤0.001
- >0.001 - ≤0.005
- >0.005 - ≤0.05
- ≤0.05 - 1.0

NOTES

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ISSUE PURPOSE

Environmental Statement

PROJECT NUMBER

60664324

FIGURE TITLE

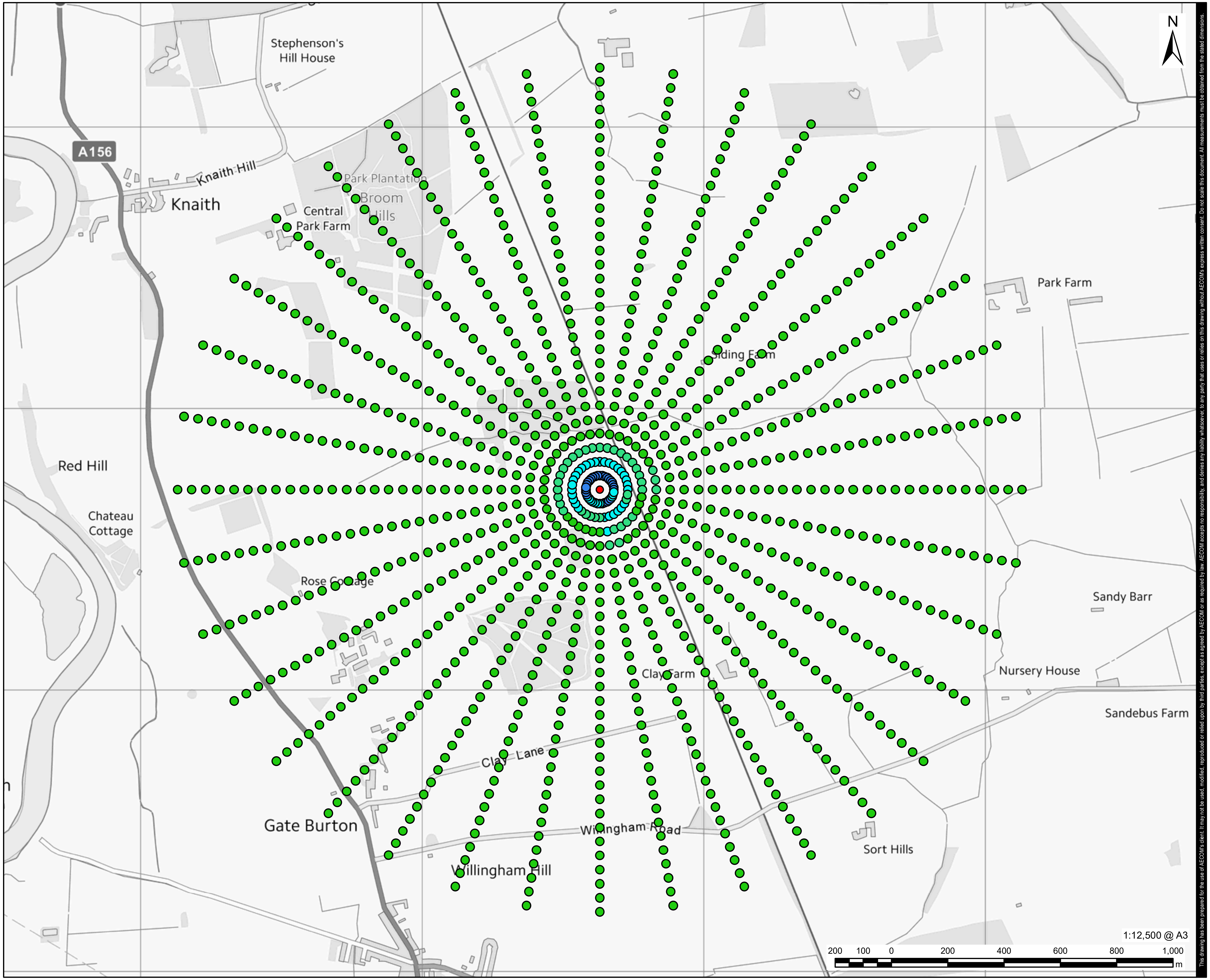
Relative Dilution from Source Based on 99th %ile Value at Gate Burton Energy Park BESS

FIGURE NUMBER

Figure 3

Annex C. Figure 4: Relative Dilution from Source Based on 90th %ile at Gate Burton Energy Park BESS

Filename: \\na.aecomnet.com\lfs\EMEA\Croydon-UKCRD1\Legacy\UKCRD1FP001\UKCRD1FP001-V1\E\projects\general\GIS\Projects\Gate Burton Energy Park\02_Maps\Environmental Statement\Chapter 15 - Other\APP_ES_Figure4_P90.mxd Revision: 01 Drawn: VC Checked: GG Approved: WB Date: 2022-10-25



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PROJECT

Gate Burton Energy Park

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Sunley House
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LEGEND

Source

Relative Dilution Polar Plot

- ≤0.0005
- >0.0005 - ≤0.001
- >0.001 - ≤0.005
- >0.005 - ≤0.05
- ≤0.05 - 1.0

NOTES

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ISSUE PURPOSE

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PROJECT NUMBER

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FIGURE TITLE

Relative Dilution from Source Based on 90th %ile Value at Gate Burton Energy Park BESS

FIGURE NUMBER

Figure 4