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ACP-056-2024
Darlington TRA for Drone Delivery Service

Noise Impact Assessment

Amendment Record

Amendment/ Revision/ Issue Number	Date	Details of change
Issue 1	27/08/2025	Initial Release

Acronyms / Abbreviations

Acronym	Definition
ACP	Airspace Change Proposal
BVLOS	Beyond Visual Line of Sight
CAA	Civil Aviation Authority
DAA	Detect And Avoid
L_{Aeq}	Equivalent Continuous Sound Level
L_{Amax}	Maximum Sound Level
LOAEL	Lowest Observable Adverse Effect Level
MME1	(Amazon Darlington Fulfillment Center designation)
NPPF	National Planning Policy Framework
NPSE	Noise Policy Statement for England
PPG	Planning Practice Guidance
SOAEL	Significant Observable Adverse Effect Level
SPL	Sound Pressure Level
TRA	Temporary Reserved Area
UAS	Unmanned Aircraft System

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1 Introduction

As part of the incremental roll-out in the UK, and under the BVLOS Sandbox initiative, Prime Air intends to implement a Temporary Reserved Area (TRA) under the CAA's CAP2616 TRA Sandbox initiative.

The TRA will allow Prime Air to commence an initial commercial drone delivery service communities within Darlington and surrounding areas.

This document had been produced to provide a qualitative and quantitative summary of the anticipated noise impact of the proposed Prime Air operations, as well as any impact noise impact associated any air traffic pattern changes with the implementation of the Temporary Reserved Area.

Prime Air recognises the potential sensitivities with drone noise emissions and so, in addition to the CAP1616-based assessment criteria, Prime Air has included additional considerations as part of this report.

2 Background

The Prime Air organisation is tasked with developing Amazon's next generation delivery capability using drones. As part of Prime Air's evolution, we plan to scale our drone delivery service to established Amazon locations both across the USA and internationally.

The UK is an important market for Amazon, and we want to delight our customers in the UK by offering the ability to order and receive qualifying Amazon packages within 30 minutes, as they currently do in several locations across the US.

As part of this ACP, Prime Air is currently planning for a 6-month demonstration period running between December 2025 and June 2026, with the possibility to extend by an additional 6 months (to December 2026), depending data gathering requirements as part of the BVLOS/DAA demonstrations.

Therefore, Prime Air considers Para 4.17 of CAP1616g[1] to be more applicable for this Noise Impact Assessment.

Prime Air intends to conduct day-time flights between 09:00 and 17:00 up to a maximum of 21 flights/hr. In practice, the frequence of flights is likely to be lower than this, and subject to customer demand profiles during the day. From experience gained with other Prime Air operations, there is typically a morning peak as order backlogs are reduced reducing to low frequency flights throughout the day. It is not yet known what the Darlington demand profile will be, however, this is likely to increase over time as the operation establishes.

Prime Air intends to ensure the CAA remains fully briefed on the service demand throughout all Sandbox operations (and beyond).

[1] https://www.caa.co.uk/our-work/publications/documents/content/cap1616g/

3 Additional Considerations

A noise assessment has been undertaken to support this ACP application as well as an associated planning application for the development of the drone operations centre at the Amazon Fulfilment centre 'MME1'.

Noise surveys have been undertaken and the results used to verify predictions of the effects of noise.

As an additional reference, a reasoned determination of the terms described in the Noise Policy Statement for England LOAEL (Lowest Observable Adverse Effect Level) and SOAEL (Significant Observable Adverse Effect Level) have been included in this assessment.

The measured noise emissions from the Prime Air MK30 drone were used to inform a noise modelling exercise for the Darlington operations. This assessment has been undertaken to establish the operational noise levels at nearby sensitive receptors resulting from takeoff/landing, flyovers from MK30 drones.

The outcome of the assessment shows that predicted internal noise levels (those residing within domestic properties) are below the determined SOAEL criteria for habitable rooms. There is currently a lack of planning policy precedent within England to assess distribution centre deliveries to residential homes, however, to address concerns raised during initial planning consultations a further assessment has been undertaken to predict the potential noise levels associated with deliveries to residents.

4 Linking to the Planning Permission

Planning Practice Guidance (PPG): Noise[2] provides further guidance with regard to the assessment of noise within the context of Planning Policy. The overall aim of this guidance, tying in with the principles of the National Planning Policy Framework (NPPF) and the Explanatory Note of the Noise Policy Statement for England (NPSE), is to "identify whether the overall effect of noise exposure is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation."

A summary of the effects of noise exposure associated with both noise generating developments and noise sensitive developments is presented within the PPG and shown in Table 1 below:

[2] https://www.gov.uk/guidance/noise--2

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not present	No Effect	No Observed Effect	No Specific Measures Required
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No Specific Measures Required
Lowest Observed Adverse Effect Level (LOAEL)			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level (SOAEL)			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

Table 1 – NPPG Noise Exposure Hierarchy

5 Assessment Criteria

As described by Para 4.17 of CAP1616g, the noise impact has been assessed with reference to the 65dB L_{ASmax} threshold, however, as part of our separate community outreach programme, Prime Air had already started community outreach with a leaflet drop, local press, and a community drop-in event, held in February 7th 2025.

While not considered by CAP1616i, the assessment of the proposed operation has also been conducted in terms of LOAEL and SOAEL, and to consider the requirement described in the Institute of Acoustics Feb 22 Briefing Note[3] to *'Establish an acceptable level of noise'* and *'setting maximum noise levels as being essential'* Table 2 presents equivalent noise levels and associated actions with the target noise level criteria identified.

[3] https://www.ioa.org.uk/sites/default/files/briefing_note_-_noise_from_drones_final_feb_22.pdf

Again, while not strictly applicable to this ACP, an additional consideration has been included, for reference, for period of 1 hour (L_{Aeq} and L_{max}), to provide health based (in accordance with the NPSE principles) operational noise levels that may be undertaken at any worst-case hour during the daytime operational period. The noise level criteria detailed below have been derived from the World Health Organisation (1999) 'Guidelines for Community Noise', with an addition of 5 dB between the LOAEL and the SOAEL, with an addition of 5 dB between the LOAEL and the SOAEL for daytime internal disturbance from instantaneous (L_{Amax}) noise levels.

Noise Sources	Noise Level Criteria	Justification for Effect Level- Action Required
No Observed Adverse Effect Level (NOAEL)		
Absolute internal noise criteria for the following noise sources with windows closed: • Daytime UAS Takeoff/Landing Events • Daytime UAS Delivery Flyovers • Typical Delivery Events	Noise levels are below: Habitable Rooms: - 35 dB$L_{Aeq,1hour}$ - $L_{AFmax,1hour}$ noise levels do not exceed: 50 dB $L_{AFmax,1hour}$	Table 1 in World Health Organisation (1999) Guidelines on Community Noise Consideration of baseline Lmax levels from passing vehicles/sirens/aircraft etc **Action Required:** None
Lowest Observed Adverse Effect Level (LOAEL)		
Absolute internal noise criteria for the following noise sources with windows closed: • Daytime UAS Takeoff/Landing Events • Daytime UAS Delivery Flyovers • Typical Delivery Events	Noise levels are between: Habitable Rooms (internal levels) : - 35-40 dB $L_{Aeq,1hour}$ - 50-60 dB $L_{AFmax,1hour}$	Consideration of baseline Lmax levels from passing vehicles/sirens/aircraft etc. **Action Required:** Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level (SOAEL)		
Absolute internal noise criteria for the following noise sources with windows closed: • Daytime UAS Takeoff/Landing Events • Daytime UAS Delivery Flyovers • Typical Delivery Events	Noise levels are above: Habitable Rooms (internal levels): - 40 dB$L_{Aeq,1hour}$ - 60 dB $L_{AFmax,1hour}$	Consideration of baseline Lmax levels from passing vehicles/sirens/aircraft etc **Action Required:** Additional mitigation required to achieve effect of SOAEL or less.

Table 2 – Noise Level Criteria and Actions

6 Assessment Methodology

6.1 Noise Modelling

Three-dimensional noise modelling has been undertaken based on the monitoring data to predict noise levels at several locations both horizontally and vertically. CADNA noise modelling software has been used. This model is based on ISO 9613-2 noise propagation methodology and allows for detailed prediction of noise levels to be undertaken for large numbers of receptor points and different noise emission scenarios both horizontally and vertically. The modelling software calculates noise levels based on the emission parameters and spatial settings that are entered. Input data and model settings as given in Table 3 below have been used.

Parameter	Source	Details
Noise Modelling Software	Datakustik GmbH	CadnaA (Computer Aided Noise Abatement)
Horizontal distances – around site	OpenStreetMap	OpenStreetMap
Ground levels – around site	DEFRA	• LiDAR 2m DTM
Building heights – around site	Tetra Tech Observations	• 4.0m height for one-storey properties • 8.0 m height for two-storey properties • 3.0m per additional storey
Receptor positions*	Tetra Tech	• 1.5 m for ground floor properties • 4.0m height for first-floor properties • 3.0m per additional storey • 1.5m height for monitoring validation locations.
Modelling Parameters	Tetra Tech	• Ground Absorption: G = 0.5 (soft ground)† • Order of Reflections: 2
UAS Movement Methodology	Tetra Tech	Movements to be modelled as line sources.

*All receptors modelled 1.0m from building façade unless otherwise stated.
† All car parks & roads are assumed to be reflective (G = 0)

Table 3 – Modelling parameter sources & inputs

In most instances, worst-case values have been used to ensure a conservative approach to the noise impact assessment.

6.2 MK30 Noise Data

Noise emissions data from the MK30 drone, collected from US operations, is included for the following scenarios with and without load:

- Hover
- Overflight
- Take-off, overflight, landing

The noise measurements for each scenario were undertaken by Prime Air with 13 microphones at a height 1.5m above ground level along the drone's flight path and the measurements were repeated for each scenario. The measurements were taken in free-field conditions with soft grounds underneath.

Figure 1 below presents the maximum sound pressure level recorded at the 13 microphones during each recording interval with the height of the drones above ground level for the take-off, overflight and landing scenario. The height of the drone above ground level and the coordinates of the drone and microphones have been used indicatively to establish the average sound power level of the drone during each take-off, overflight, hover and landing phases.

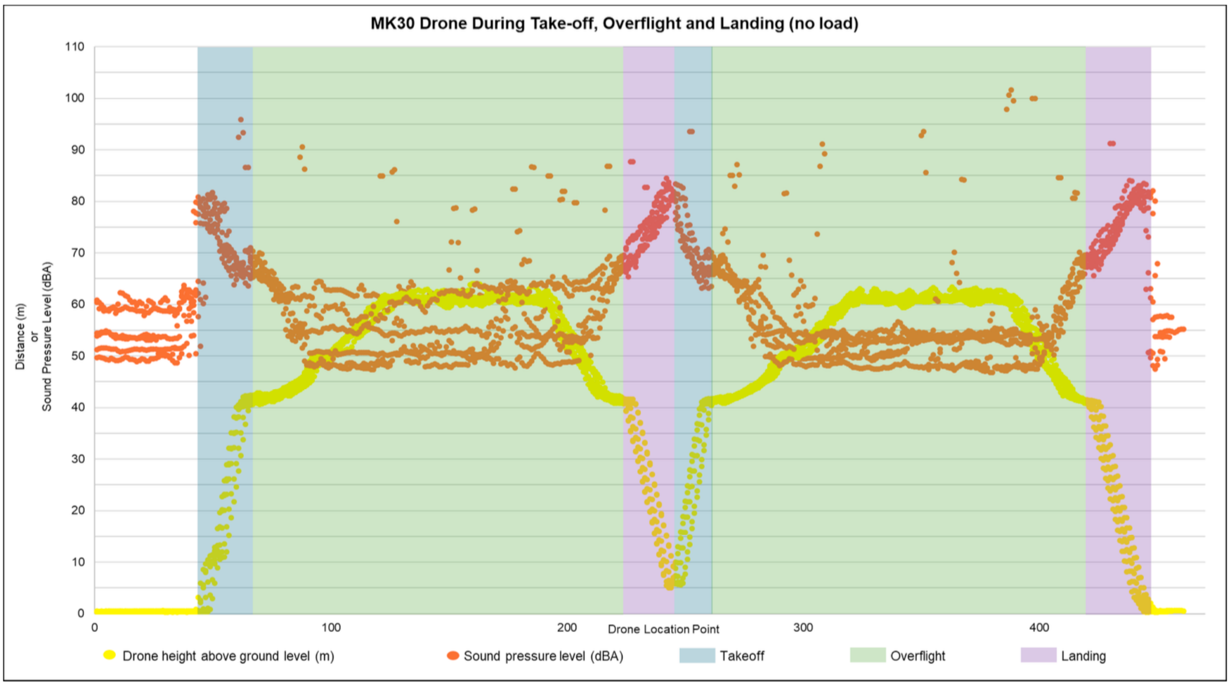

Figure 1 – Maximum SPL measured at microphones

This is considered to be a more conservative approach when compared to L_{ASmax} (with tonal correction), as virtually no averaging is applied giving an almost instantaneous SPL.

The results are summarised in Table 4 below, with the full results provided in Appendix B Table 11.

Event		Average Sound Power Level (dBA)	Modelled Source	Drone Altitude / Change in Altitude (m)	Duration of Event (s)
Outbound	Take-off from Amazon (with load)	109.1	Line source	4 - 35	20
	Transition (hover with load)	113.1		35 - 60	20
	Flyover (with load)	100.1		60	120*
	Transition (hover with load)	113.1		60 - 35	10
	Landing for delivery (with load)	112.1		35 - 4	10
Inbound	Take-off after delivery (without load)	107.1		4 - 60	30
	Transition (hover without load)	112.1		60 - 105	30
	Flyover (without load)	100.1		105	120*
	Transition (hover without load)	112.1		105 - 60	30
	Landing to Amazon (without load)	111.1		60 - 4	20

*This duration is representative of the worst-case duration experienced at the receptor during the drone's flight. The total flight duration may vary depending on the distance which the drone needs to travel.

Table 4 – Existing Sensitive Receptor Locations

The sections in this table reference the various portions of the typical Prime Air delivery mission profile shown in the Figure 2 below.

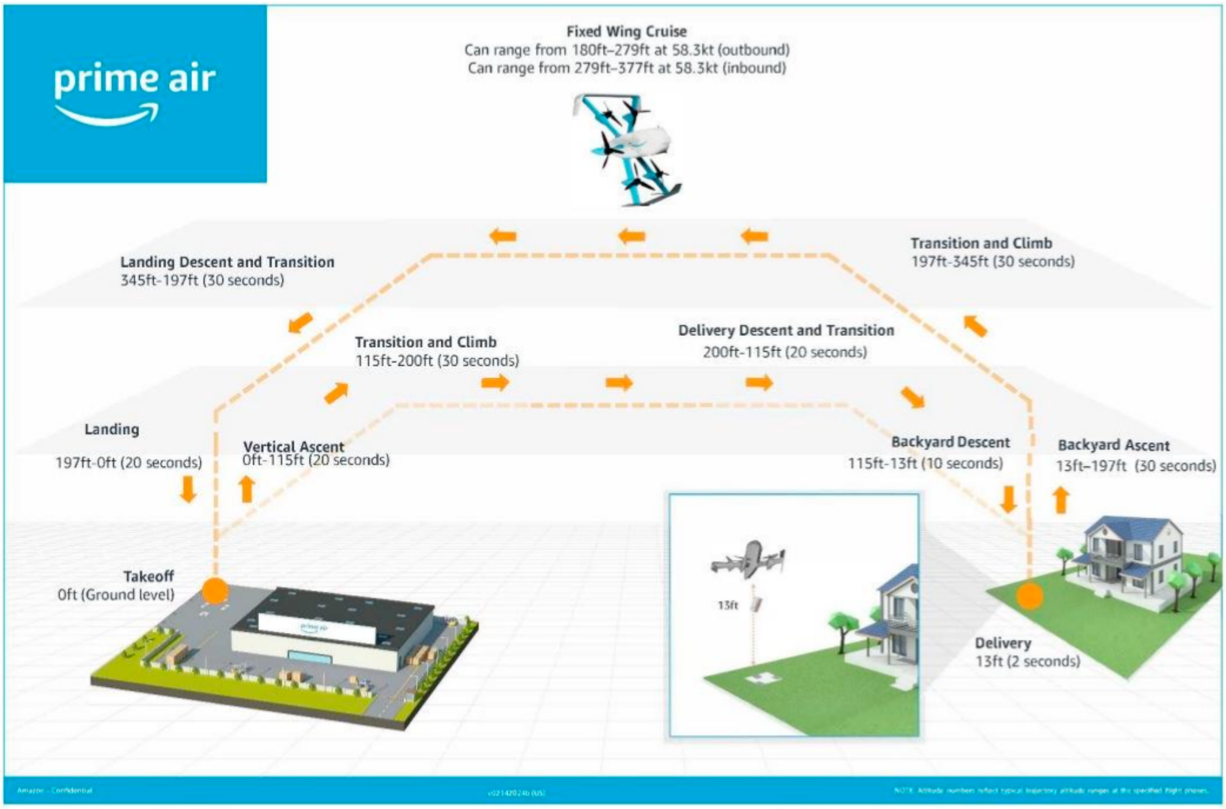

Figure 2 – Standard Prime Air delivery mission profile.

6.3 Sensitive Receptors

To help assess the potential noise impact, potential and/or representative sensitive receptors were identified and are summarised in Table 1 below. Façades of the nearest noise sensitive properties to the operations centre (PADDC) have also been highlighted. The locations of the receptors are presented within Figure 3.

Ref.	Description	Type of Use	Height (m) Daytime
R01	Lingfield Close, DL1 1YG	Residential	1.5
R02	Coombe Drive	Residential	1.5
R03	Red Hall Nature Reserve	Residential	1.5
R04	South Burdon Farm	Residential	1.5
R05	Morton Parms Farm	Residential	1.5
R06	St George's Gate, DL2 1FE	Residential	1.5
R07	Near Darlington Brick Train Sculpture	Leisure	1.5
R08	Travelodge, Yarm Road	Hotel	4.0
R09	Maidendale Nature Reserve	Local Nature Reserve (LNR)	1.5
R10	Gibb Avenue, DL1 1NZ	Residential	1.5

Table 5 – Existing Sensitive Receptor Locations

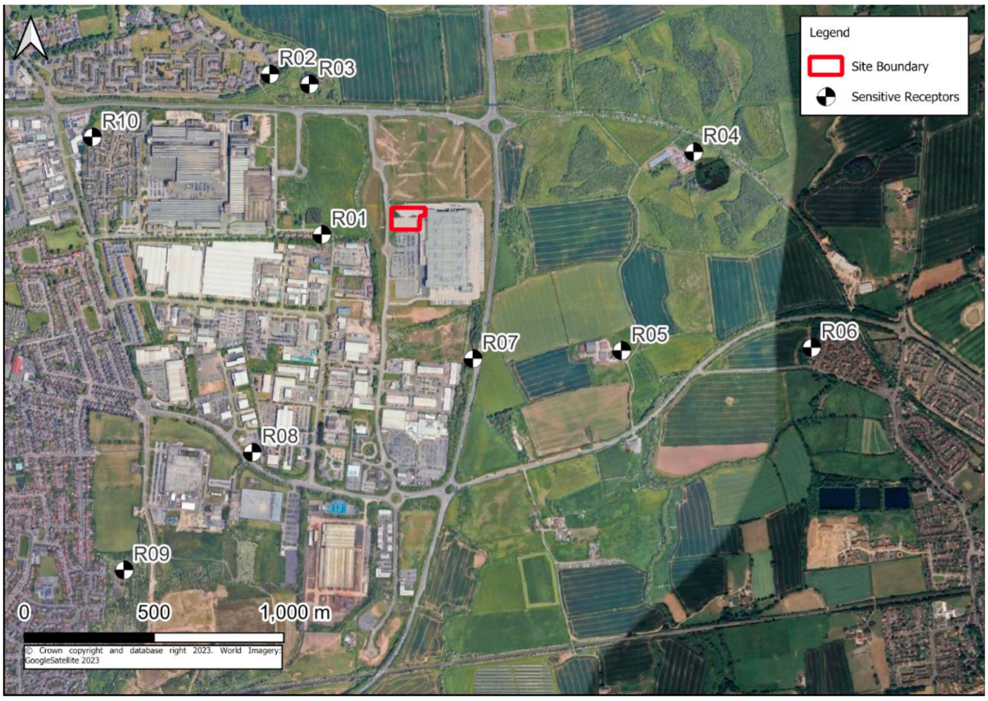

Figure 3 – Sensitive Receptor Locations

6.4 Noise Monitored Locations

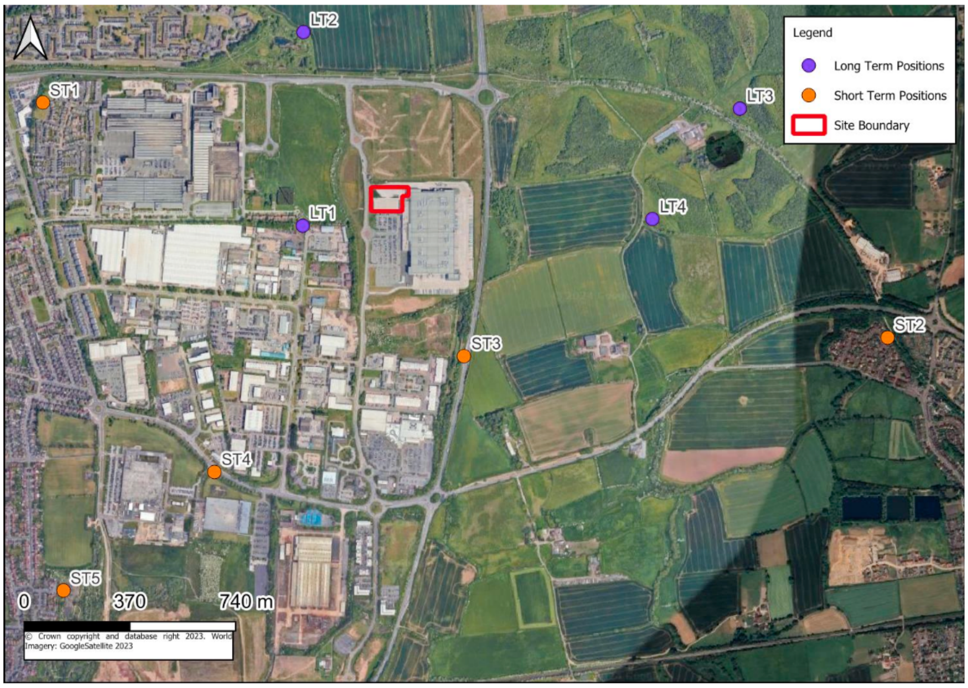

Figure 4 –Monitored Locations

7 Noise Survey Results

The dominant baseline noise sources found in the area include road traffic noise from A66, A67, Yarm Road and McMullen Road. Other contributions to the ambient noise environment consist of birdsong and trees rustling in the wind. Ambient and background noise levels are usually described using the L_{Aeq} index (a form of energy average) and the L_{A90} index (i.e. the level exceeded for 90% of the measurement period) respectively. Road traffic noise is generally described using the L_{A10} index (i.e. the level exceeded for 10% of the measurement period). For the long-term (LT) locations, the presented $L_{Aeq,T}$ and $L_{A10,T}$ are average noise levels whilst the L_{A90} is the modal noise level of each 5-minute measurement over the stated survey period.

Survey Location	Date & Time	Temperature (ºC)	Wind Speed (m/s)	Wind Direction	Cloud Cover (Oktas)	Dominant Noise Source
ST1 Day	05/06/24 10:20	12	2-3	W	6	Rustling trees and faint RTN throughout
ST1 Evening	04/06/24 20:11	12	4-5	NW	7	Rustling trees throughout
ST1 Night	04/06/24 23:44	8	1-2	W	6	Rustling trees and faint RTN throughout
ST2 Day	05/06/24 09:53	11	2-3	W	6	Rustling trees and faint RTN throughout
ST2 Evening	04/06/24 19:25	12	3-4	NW	7	Rustling trees and faint RTN throughout
ST2 Night	04/06/24 23:00	9	2-3	W	6	Rustling trees and faint RTN throughout
ST3 Day	04/06/24 14:16	16	2-3	SW	5	RTN from A66
ST3 Evening	04/06/24 19:47	12	2-3	NW	7	RTN from A66
ST3 Night	04/06/24 23:22	9	1-2	W	6	RTN from A66
ST4 Day	05/06/24 11:10	12	2-3	W	4	RTN from Yarm Road
ST4 Evening	04/06/24 21:00	11	3-4	NW	6	RTN from Yarm Road
ST4 Night	05/06/24 00:29	7	2-3	W	7	RTN from Yarm Road
ST5 Day	05/06/24 10:46	12	3-4	W	5	Trees rustling and birdsong
ST5 Evening	04/06/24 20:36	12	3-4	NW	6	Trees and bushes rustling

Table 6 – Survey Meteorological Conditions

8 Operational Noise Assessment for MK30 take-off/landings

This assessment has been undertaken to establish the operational noise levels at nearby sensitive receptors resulting from takeoff/landing of MK30 drones.

The specific flight path is subject to a large number of variables including ground-based structures, population densities, weather, etc. The flight paths are also subject to operational constraints such as no over-flight of schools/hospitals and other sensitive areas. However, deliveries will be made to residential areas.

For the purposes of this assessment, theoretical flight paths have been distributed in 12 directions with 4 no. return flights (8 UAS flyovers) inputted along each path during a 1-hour assessment period.

The average daytime noise levels for this scenario are present in Figure 5 below.

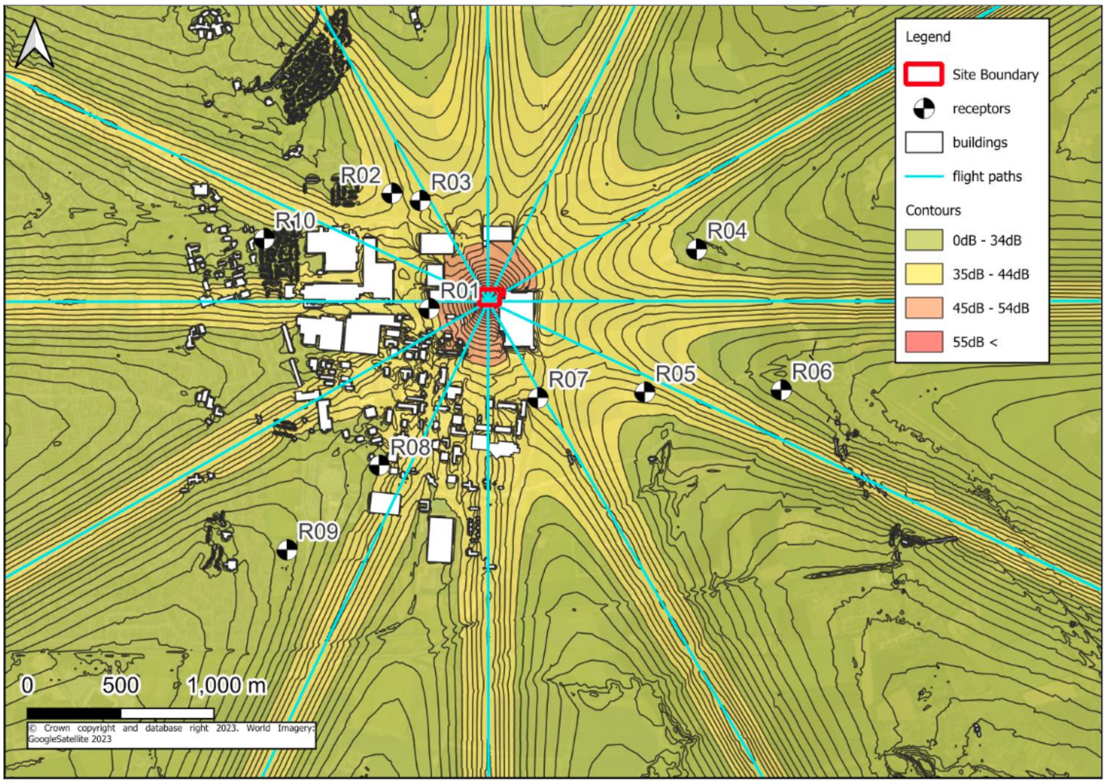

Figure 5 – Theoretical flight path Daytime Levels $L_{Aeq,1\ hour}$

9 Residential Delivery Assessment

9.1 Noise Levels from Deliveries at example residential locations

Noise emissions will be apparent during the delivery phase. This typically lasts for ~60seconds with a peak experienced, at the property being delivered to, at the lowest point in the delivery profile (4m above the ground), the peak diminishes following delivery as the drone climbs back to the cruise height.

Therefore, this assessment has been undertaken to establish the $L_{Aeq,1hours}$ noise levels resulting from the delivery by MK30 drones to residential locations. In this scenario, 3 no. drones have been modelled to leave the MME1 site simultaneously and travel along different flight paths for deliveries to represent different neighbourhoods.

Delivery location	Highest $L_{Aeq,1hours}$ Noise Level at Delivery Recipient dB	Highest $L_{Aeq,1hours}$ Noise Level at Neighbour dB	Representative $L_{Aeq,1hours}$ Noise Level Along Flight Path at 1.5m High Above Ground dB
Red Hall	55.0	50.0	36.3
Haughton Le Skerne	56.0	52.0	32.6
Eastbourne	56.0	53.0	36.4

Table 7 – Residential Delivery Noise Assessment

It can be seen from Table 7 that the receptors experiencing the highest noise levels at the façade would typically be the delivery recipients, which are likely to be less sensitive to potential noise disturbance associated with the delivery event. As such, the following assessments consider the highest noise level at a neighbouring property and is presented in the following section.

9.2 Noise Intrusion at Neighbouring Residential Properties

Internal noise levels at sensitive receptor locations, have been assessed both with windows open and closed, where a reduction from a partially open window of 13 dB has been used, and with windows closed where an assumption of double glazing with a sound reduction of 30 dB R_{w+Ctr} has been used. Results of the noise intrusion assessments for average and maximum daytime noise levels are presented within the Table 8 and Table 9below

Location	Predicted Noise Level from Operations	Internal Noise Level with windows open	Internal Noise Level with windows closed
Red Hall	50.0	37.0	20.0
Haughton Le Skerne	52.0	39.0	22.0
Eastbourne	53.0	40.0	23.0
All values are sound pressure levels in dBA re: 2 x 10^{-5} Pa.			

Table 8 – Daytime Noise Intrusion Levels from UAS Delivery dB LAeq,1hour

Location	Predicted Noise Level from Operations	Internal Noise Level with windows open	Internal Noise Level with windows closed
Red Hall	66.0	53.0	36.0
Haughton Le Skerne	70.0	57.0	40.0
Eastbourne	72.0	59.0	42.0
All values are sound pressure levels in dBA re: 2 x 10^{-5} Pa.			

Table 9 – Daytime Noise Intrusion Levels from UAS Delivery dB L_{Amax}

The outcome of the assessment showed that predicted internal noise levels are below the determined SOAEL criteria for habitable rooms with both windows opened and closed.

9.3 Noise from UAS vs Van Deliveries at Neighbouring Residential Properties

For context, source noise levels of existing van deliveries have been presented in Appendix B. The following noise levels have been calculated based on 2 no and van movements (outbound and inbound). The following calculations have been used to represent Van's arriving/exiting along the residential access road at each assessment location. It is assumed that 1 no van is predicted to arrive/leave along the residential access road during the daytime, corrected over a 1-hour daytime (07:00 – 23:00) period.

A comparison of the noise level at a neighbouring between deliveries via UAS and deliveries via van are presented within Table 10.

Location	Source Type	Predicted Noise Level from Van Delivery	Predicted Noise Level from UAS Delivery	Difference between UAS and Van Delivery
Red Hall	L_{Aeq}	54	50	-4
	L_{max}	69	66	-3
Haughton Le Skerne	L_{Aeq}	55	52	-3
	L_{max}	66	70	+4
Eastbourne	L_{Aeq}	51	53	+2
	L_{max}	71	72	+1
All values are sound pressure levels in dBA re: 2 x 10^{-5} Pa.				

Table 10 – Van vs UAS delivery in residential areas (dB)

Table 5.5 shows that during a 1-hour assessment period, the difference in noise level from van to UAS deliveries is between -4dB lower to +4dB higher at the nearest façade of the neighbouring property. As such, the noise exposure during is likely to be marginally less or similar to that experienced during a residential delivery via van. However, other context to be noted are that the duration of the drone delivery is very short (~30 seconds), compared to the van delivery (2 minutes) and similarly L_{max} events from a van delivery such as van door banging brake, manoeuvring and knocking on doors, are likely to be more potentially disturbing events than the drone delivery.

10 Impact to other aviation operations

With the implementation of the TRA and access requirements to enter the TRA, it is expected that more traffic may choose to over fly the Prime Air operations, avoiding transiting the TRA entirely. It is conceivable then that noise from crewed aircraft in the area is reduced while the TRA is in place and active. Given the limited number of flights low-level General Aviation flights and available vertical airspace above the TRA, it is not considered that established traffic patterns will be impacted significantly, other than a potential slight vertical shift, therefore, no negative affects are expected in other locations surrounding the TRA.

11 Conclusion

Based on the assessment summarised in this document and from Prime Air operational experience in the US, the noise impact is expected to be low throughout the operational area described in this ACP. However, Prime Air acknowledges the relative newness of drone delivery operations in the UK and is committed to introducing the Prime Air service sensitively.

Additional community outreach will take place in 2025 and into 2026, where local residents and interested parties will be given the opportunity to learn more about the Prime Air delivery system and field questions to Prime Air representatives.

Community events are also planned for once live operations commence, where members of the local community will have the opportunity to come and witness operations and at the operations centre.

Feedback from the community will remain possible throughout Prime Air operations through multiple channels including dedicated email addresses, telephone numbers and normal Amazon customer services.

Prime Air will continuously monitor this feedback for any potential adverse impacts for consideration in the overall operation design.

12 Appendix A: MK30 Noise input data

Noise Source	Type	Octave Band Sound Power Level (L_w)								Sound Power Level (L_w(A))	Drone altitude (m)	Duration of Event (s)
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz			
Takeoff from Amazon (with load)	Average	95.9	94.7	100.3	104.4	103.1	103.1	100.4	98.7	109.1	0 - 35	20
Transition (hover with load)	Average	99.9	98.7	104.3	108.4	107.1	107.1	104.4	102.7	113.1	35 - 60	20
Flyover (with load)	Average	86.9	85.7	91.3	95.4	94.1	94.1	91.4	89.7	100.1	60	120
Transition (hover with load)	Average	99.9	98.7	104.3	108.4	107.1	107.1	104.4	102.7	113.1	60 - 35	10
Landing for delivery (with load)	Average	98.9	97.7	103.3	107.4	106.1	106.1	103.4	101.7	112.1	35 - 4	2
Takeoff after delivery (without load)	Average	93.9	92.7	98.3	102.4	101.1	101.1	98.4	96.7	107.1	4 - 35	30
Transition (hover without load)	Average	98.9	97.7	103.3	107.4	106.1	106.1	103.4	101.7	112.1	35 - 60	30
Flyover (without load)	Average	86.9	85.7	91.3	95.4	94.1	94.1	91.4	89.7	100.1	60	120
Transition (hover without load)	Average	98.9	97.7	103.3	107.4	106.1	106.1	103.4	101.7	112.1	60 - 35	30
Landing to Amazon (without load)	Average	97.9	96.7	102.3	106.4	105.1	105.1	102.4	100.7	111.1	35 - 0	20

Table 11 – Noise Input Data for the MK30