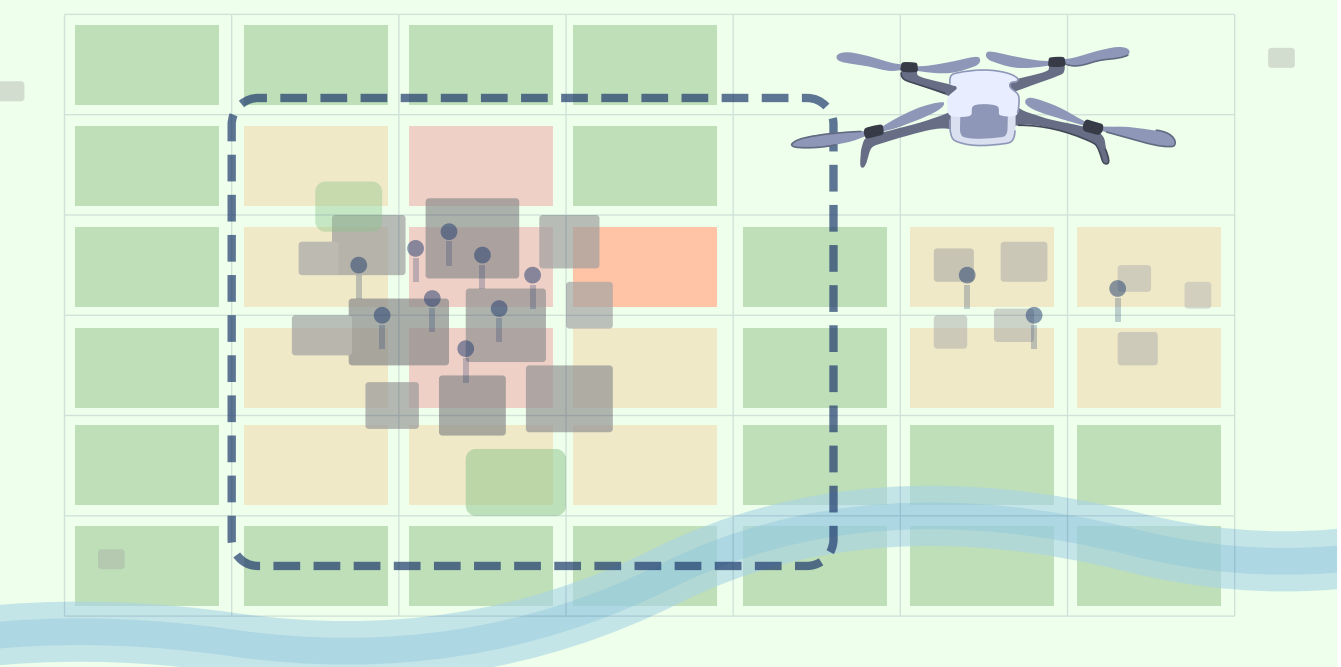
UK Civil Aviation Authority

UK SORA Best Practice

Determining Population Density

CAP3239C



› A best practice guide for calculating population density in support of UK Specific Operations Risk Assessment (SORA) applications under UK Regulation (EU) 2019/947.

› This guide covers the key steps for determining population density as part of a UK SORA application, helping you provide the evidence the CAA needs to assess ground risk.

⚠ Population density is a critical input to the intrinsic Ground Risk Class (iGRC) in UK SORA. An inaccurate assessment may delay your application or result in disproportionate risk mitigations.

High-Level Process

A simple step-by-step guide to determine the population density for your UK SORA application. This process helps the CAA understand the risk to people on the ground and is a key part of your submission.

Why is this important?

Population density is a critical input to the intrinsic Ground Risk Class (iGRC) in UK SORA. An accurate assessment ensures your risk mitigations are proportionate and your application is processed efficiently by the CAA.

1

Define Your Operational Volume & iGRC Footprint

Precisely define your operational volume in three dimensions

2

Select Appropriate Population Density Data Sources

Choose authoritative, up-to-date data with appropriate resolution

3

Calculate the Maximum Population Density

Evaluate the entire iGRC footprint to find the highest density

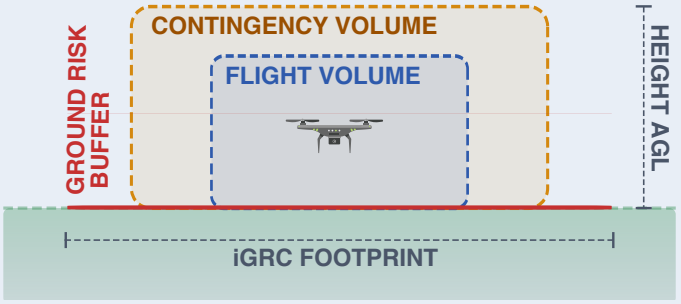
4

Document Your Methodology & Provide Evidence

Compile clear, well-referenced documentation for your UK SORA application

1 Define Your Operational Volume & iGRC Footprint

Precisely define your operational volume in three dimensions



Defining the 3D Operational Space

Precisely define your operational volume in 3D:

- **Horizontal boundaries** as a polygon or radius around a centre point (latitude/longitude).
- **Vertical extent** as height above ground level (AGL) or altitude above mean sea level (AMSL).

Three Volume Layers

- **Flight Volume (FV)** — The volume in which the UA conducts normal operations using standard operating procedures, remaining within defined operational boundaries at all times.
- **Contingency Volume (CV)** — The volume surrounding the Flight Volume. Entry into the Contingency Volume is considered an abnormal situation, requiring the execution of contingency procedures to return the UA to the Flight Volume.
- **Ground Risk Buffer (GRB)** — The ground area surrounding the footprint of the Contingency Volume. In the event of a loss of control of the operation, the UA is expected to end its flight within the Ground Risk Buffer.

Visualisation Tools

Use tools like KML/KMZ files (Google Earth format) to overlay and visualise these volumes on maps.

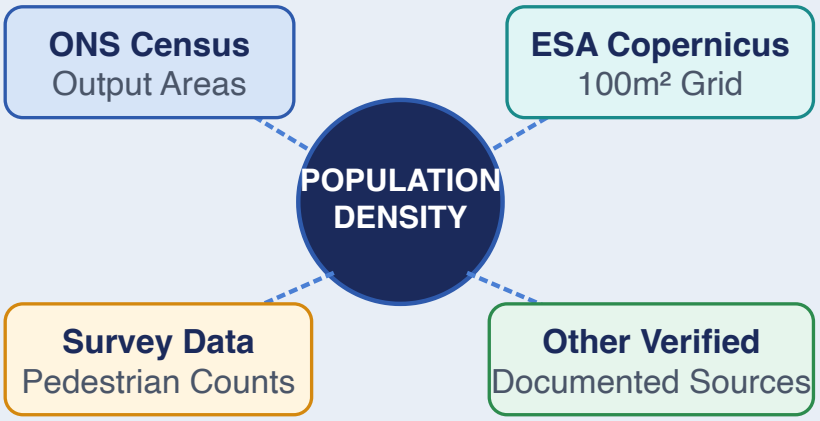
Provide clear calculations and rationale for the dimensions of your operational volumes.

Key Requirement

Provide a map showing your operational volumes, along with clear calculations and rationale for the dimensions of these volumes, in your application evidence.

2 Select Appropriate Population Density Data Sources

Choose authoritative, up-to-date data with appropriate resolution



☐ Recommended Data Sources

Select the most appropriate data source(s) for your proposed operation:

- **ONS Census Data** — UK Office for National Statistics output areas
- **ESA Copernicus Data** — Global Human Settlement Layer at 100m² resolution
- **Survey Data** — pedestrian counts, local surveys
- **Other Verified Sources** — provided you document your verification process

☆ Best Practice Tip

Use authoritative, up-to-date data with an appropriate grid size relative to your maximum operational height. For operations up to 500 ft AGL, use maps with grid size greater than 200m × 200m.

ONS Census Data — Detailed Guidance

Census data represents where people are overnight, not where they are throughout the day. Data for certain locations such as city centres, event venues, beaches, and commuter areas can be misleading.

Census data works best for relatively simple operations in one site, town, or local area.

Population density is calculated by dividing the population count of each administrative unit by its land area (expressed in persons per km²). The ONS Output Areas create a "heatmap" of population densities, with the highest density value within each grid square selected to ensure accurate risk assessment.

This ensures that localised concentrations of people are not averaged out or underestimated during spatial aggregation, providing a precautionary representation of potential human exposure.

ESA Copernicus Data — Detailed Guidance

Copernicus data provides an estimated distribution of population across grid cells, using modelling assumptions about where people are likely to be.

The Copernicus Global Human Settlement Layer offers higher resolution at 100m², providing a more detailed and recent view of population distributions. It represents an average population density for a 24-hour period, rather than where people are likely to be overnight.

Copernicus data works best for BVLOS operations and those involving a route or corridor that passes through mixed areas such as residential, town centre, and industrial zones.

Population Data Links

- **England & Wales — ONS Census Maps**
  ons.gov.uk/census/maps
- **Scotland — Census Atlas**
  scotlandscensus.gov.uk/atlas
- **Northern Ireland — Census Maps**
  ni-census-maps.cantabular.com
- **ESA Copernicus — Earth Observation**
  human-settlement.emergency.copernicus.eu

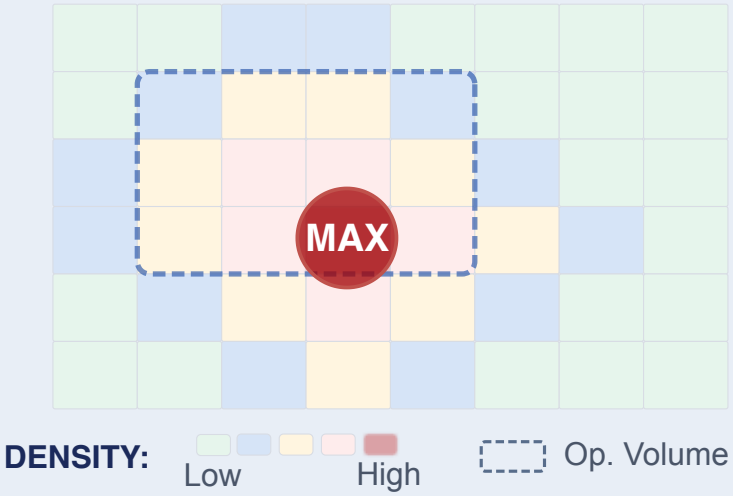
Qualitative Population Density Descriptors (Fallback)

'If no suitable quantitative data is available, or specific areas within the iGRC are over the applied threshold, you may use qualitative descriptors:

Descriptor	Max Density (ppl/km²)	Examples
Controlled / Extremely Remote	0	Restricted military zones, large bodies of water, inaccessible land
Few People May Be Present	5	Unpopulated areas with public right of way, small hamlets, moorland
Sparsely Populated	50	Hamlets, clusters of farms, small industrial sites
Lightly Populated	500	Villages, medium industrial areas, small campsites
Moderately Populated	5,000	Towns, residential homes, large industrial areas
Heavily Populated	50,000	Cities, large blocks of flats, small/medium festivals
Densest Populated	> 50,000	City centres, dense high-rise, large festivals/sporting events

3 Calculate the Maximum Population Density

Evaluate the entire iGRC footprint to find the highest density



Calculation Process

- Overlay your operational volume footprint on the population density map.
- Calculate or estimate the **maximum population density** within the entire iGRC footprint (flight volume + contingency volume + ground risk buffer).
- The resulting figure in **people per square kilometre** is what you will use in your application.

Consider Both Population Types

- **Static populations** — residents, workers
- **Temporary populations** — pedestrians, event attendees, school playgrounds, parks, beaches, campsites, festivals

Assemblies of People

Identify and provide evidence of any assemblies of people within **1 km** of the operational volume or ground risk buffer, including static or temporary gatherings.

Generic Approvals

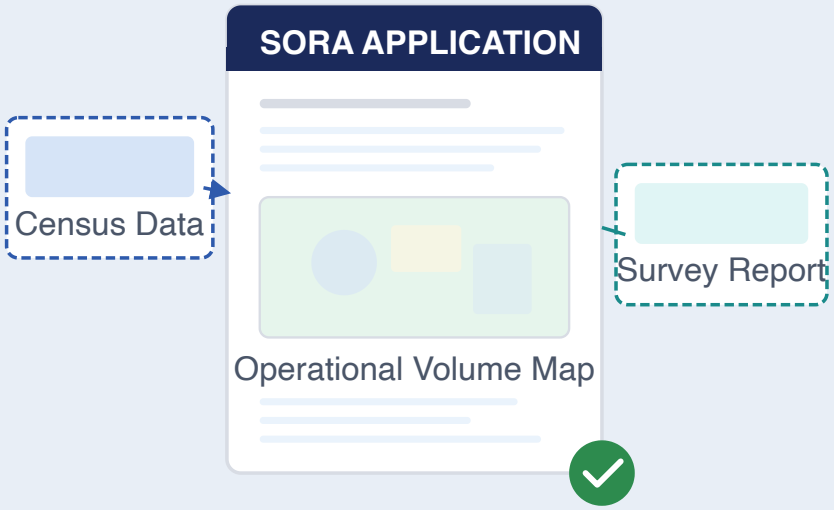
For generic approvals covering multiple locations (a minimum of three sites), provide representative examples of population density calculations for typical sites.

Controlled Ground Areas

If a controlled ground area is declared (i.e. access is restricted such that only involved persons are present), the population density for GRC assessment purposes may be considered negligible. In practice, SORA uses a nominal value (e.g. 0.5 persons/km²) rather than zero to ensure conservative and stable calculations. Evidence must be provided that the area is effectively controlled to exclude uninvolved persons.

4 Document Your Methodology & Provide Evidence

Compile clear, well-referenced documentation for your UK SORA application



Methodology Description

In your application, provide a brief description of the methodology used to determine population density, including:

- Data sources and their dates
- Grid size and resolution used
- How you accounted for temporary populations and assemblies of people
- Any assumptions or approximations made

Supporting Evidence to Upload

- Maps with operational volumes overlaid
- Population density data extracts
- Survey reports or third-party data
- Controlled ground area management plans, if applicable

Labelling Requirement

Ensure evidence is clearly labelled and referenced to the relevant application section to facilitate assessment by the CAA.

Best Practice Summary

A well-documented methodology with clear, labelled evidence significantly improves the efficiency of CAA assessment. Ensure your maps clearly show operational volumes and population density overlays, and that all data sources are cited with dates and resolution information.

Quick Reference: Height vs Grid Size

Max. Height (AGL)	Metres	Suggested Grid Size
500 ft	152 m	> 200 × 200 m
1,000 ft	305 m	> 400 × 400 m
2,500 ft	762 m	> 1,000 × 1,000 m
5,000 ft	1,524 m	> 2,000 × 2,000 m
10,000 ft	3,048 m	> 4,000 × 4,000 m
20,000 ft	6,096 m	> 5,000 × 5,000 m
60,000 ft	18,288 m	> 10,000 × 10,000 m