

# Aviation Lighting Assessment

Trinity Islands

Renaker Build Limited

August 2021

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## ADMINISTRATION PAGE

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|-----------------------|----------------------|
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## EXECUTIVE SUMMARY

### Report Overview

Pager Power has been retained to produce an Aviation Lighting Scheme for the proposed Trinity Islands development located at Water Street, Manchester. The proposed development will consist of four towers with a maximum altitude of 207.55m above mean sea level (amsl) and 180.15m above ground level (agl). Following completion of the Aviation Safety Assessment (10685A) it was deemed that a specific investigation into the aviation lighting requirement was necessary.

### Lighting Scheme Considerations

A lighting scheme for the proposed Trinity Islands development is required due to the location of the towers, safeguarding impacts upon Manchester Airport's obstacle limitation surfaces (OLS) and the respective heights of the towers.

The following was completed to determine an overall recommended aviation lighting scheme:

- A review of ANO 219 and EASA CS-ADR-DSN guidance as well as the CAA CAP 168<sup>1</sup>;
- A comparison of the guidance with respect to obstacle lighting;
- An assessment of the proposed development with respect to the Manchester Airport's OLS;
- An examination of the lighting and height of existing structures surrounding the development;
- Planning and lighting precedence;
- Consideration of the surrounding environment.

### Lighting Requirement

The following is true regarding the proposed development:

- Two of the four towers extend above 150m agl<sup>2</sup> (D1 = 180.150m and D2 = 165.900m agl);
- Two of the four towers do not extend above 150m agl (C1 = 119.475m and C2 = 145.950 agl);
- One of the towers infringes the outer horizontal surface (OHS) of Manchester Airport (D1 by 0.8572m);
- Three of the towers do not infringe the OLS (C1, C2 and D2).

Under the cited guidance aviation lighting is required.

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<sup>1</sup> Terminology/acronyms presented in Section 3.

<sup>2</sup> Based on the ground heights provided within the development plans.

## Recommended Lighting Scheme

The lighting scheme proposed includes the addition of four obstacle lights (medium intensity steady red, Type C – 2000 candela) to be fitted on the corners of the roof of towers D1 and D2. Lighting is not required or recommend for towers C1 or C2 due to their height.

No intermediate lights are recommended considering the presence of existing tall buildings near the proposed development, the aviation lighting precedence (Deansgate Square, Crown Street Phase 1 and the Beetham Tower) and presence amongst an already built up and well-lit area in the city centre of Manchester. This however should be discussed further with Manchester Airport.

The figure<sup>3</sup> below shows a top-down representative image of the proposed development and recommended lighting scheme. The red circles indicate the proposed lighting positions.



Recommended lighting scheme – top-down

## Next steps

The lighting scheme will be made available to Manchester Airport for their consideration.

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<sup>3</sup> Source: Aerial image copyright © 2021 Google.

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## ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 50 countries within South Africa, Europe, America, Asia and Australasia.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects.
- Building developments.
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

## 1 INTRODUCTION

### 1.1 Overview

Pager Power has been retained to produce an Aviation Lighting Scheme for the proposed Trinity Islands development located at Water Street, Manchester. The proposed development will consist of four towers with a maximum altitude of 207.55m above mean sea level (amsl) and 180.15m above ground level (agl).

Due to their location and height, an investigation into the aviation lighting requirement is necessary. Therefore the purpose of this assessment is to determine the design of an appropriate aeronautical lighting scheme considering aviation lighting requirements. In detail, this report includes:

- A review of ANO 219 and EASA CS-ADR-DSN guidance as well as the CAA CAP 168;
- Determination of the applicable rules for aeronautical ground lighting;
- Lighting precedence and other lighting specific considerations;
- Determination of a suitable lighting scheme.

Following the analysis final conclusions and recommendations are made.

### 1.2 Coordinate System

Unless otherwise stated all coordinates used within this report are in British National Grid (OSGB36 datum) or WGS84 latitude and longitude.

## 2 DEVELOPMENT PLANS

### 2.1 Development Description

The Site comprises two distinct plots of land, 'Site C' (0.89 hectares) to the north and 'Site D' (0.89 hectares) to the south, divided by the A6042. The Site, until recently, was used as a compound for the Ordsall chord development, however it is currently being used as a surface level car park.

Site C comprises two residential towers of approximately 34 and 42 residential storeys, providing circa 900 residential units. Site D comprises two residential towers of approximately 48 and 57 residential storeys, providing circa 1000 residential units. Each tower sits above a two-deck podium with associated two-storey underground resident parking.

### 2.2 Proposed Development Elevations

The maximum height of each tower above ordnance datum (AOD) and above ground level (agl)<sup>4</sup> is presented below:

- C1: Maximum elevation AOD = 146.875m. Maximum elevation agl = 119.475m.
- C2: Maximum elevation AOD = 173.350m. Maximum elevation agl = 145.950m.
- D1: Maximum elevation AOD = 207.550m. Maximum elevation agl = 180.150m.
- D2: Maximum elevation AOD = 193.300m. Maximum elevation agl = 165.900m.

#### 2.2.1 Proposed Development Locations

Table 1 below presents the representative centre points of the towers used within the technical analysis.

| Tower | Longitude (°) | Latitude (°) |
|-------|---------------|--------------|
| C1    | -2.260250     | 53.477205    |
| C2    | -2.260792     | 53.476734    |
| D1    | -2.262160     | 53.476472    |
| D2    | -2.261975     | 53.475931    |

Table 1 Proposed development representative centre points

<sup>4</sup> Considering a ground level of 27.4m as per drawing 10364-Z1-SHP-G200-SE-0001.

## 2.3 Proposed Development Boundary

The red line boundary for the proposed development is shown in Figure 1<sup>5</sup> below. The two boundaries are defined as Site C and Site D.

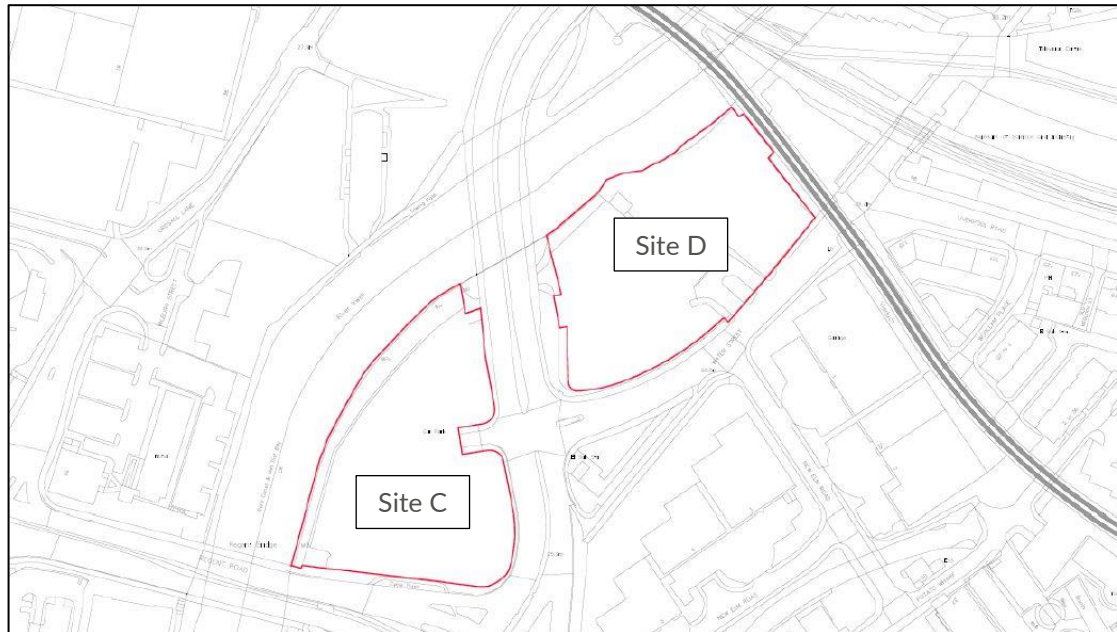


Figure 1 Proposed development red line boundary

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<sup>5</sup> Source: Simpsonhaugh (cropped).

## 2.4 Proposed Development Boundary

The red line boundary for the proposed development overlaid on aerial imagery is shown in Figure 2<sup>6</sup> below.

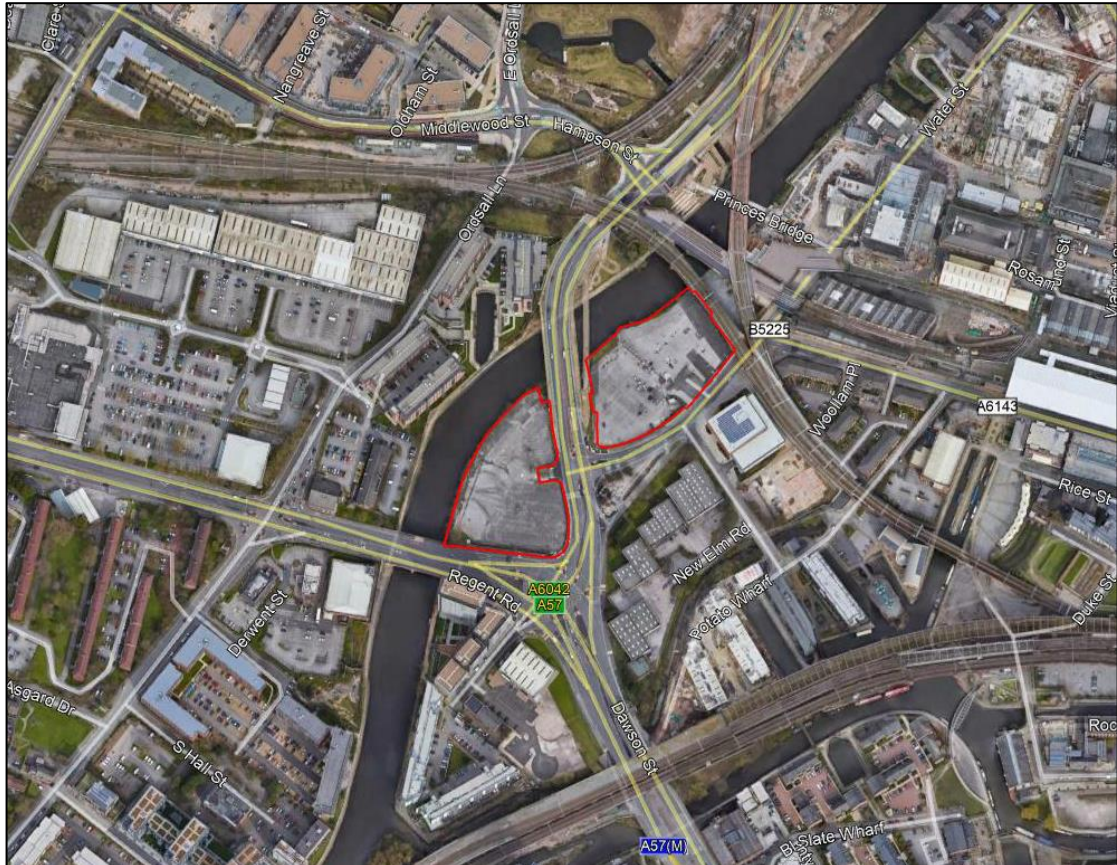


Figure 2 Proposed development red line boundary overlaid on aerial imagery

<sup>6</sup> Source: Copyright © 2021 Google.

## 2.5 Proposed Development Ground Floor Plan and Elevation

The ground floor plan for the proposed development is shown in Figure 3<sup>7</sup> below.

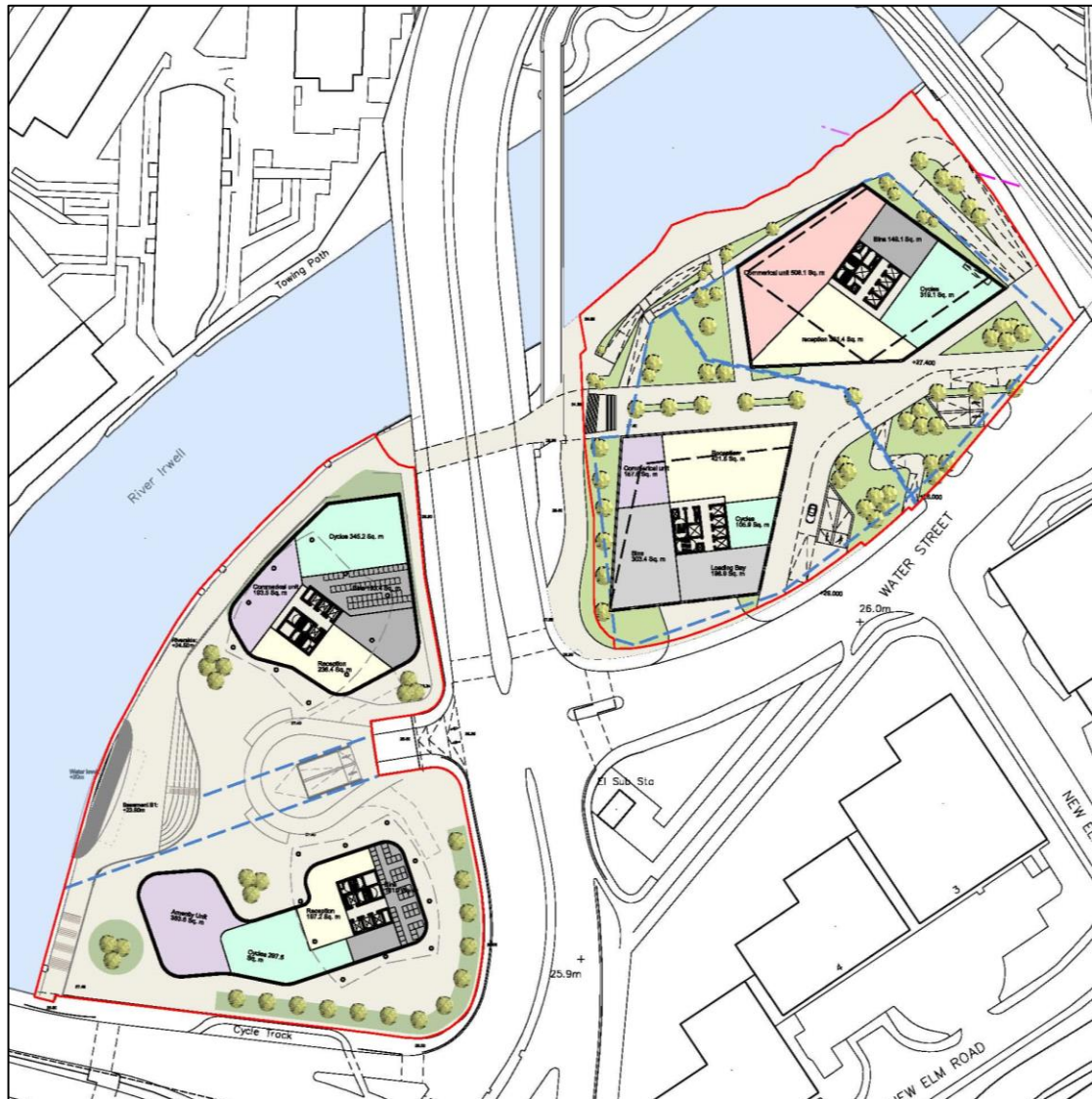


Figure 3 Proposed development ground floor plan

<sup>7</sup> Source: Simpsonhaugh (cropped).

## 2.6 Proposed Development Footprint and Elevations

Figures<sup>8</sup> 4 and 5 below and on the following page show the proposed footprints of each tower with co-ordinates. The maximum elevation of the towers AOD are also shown.

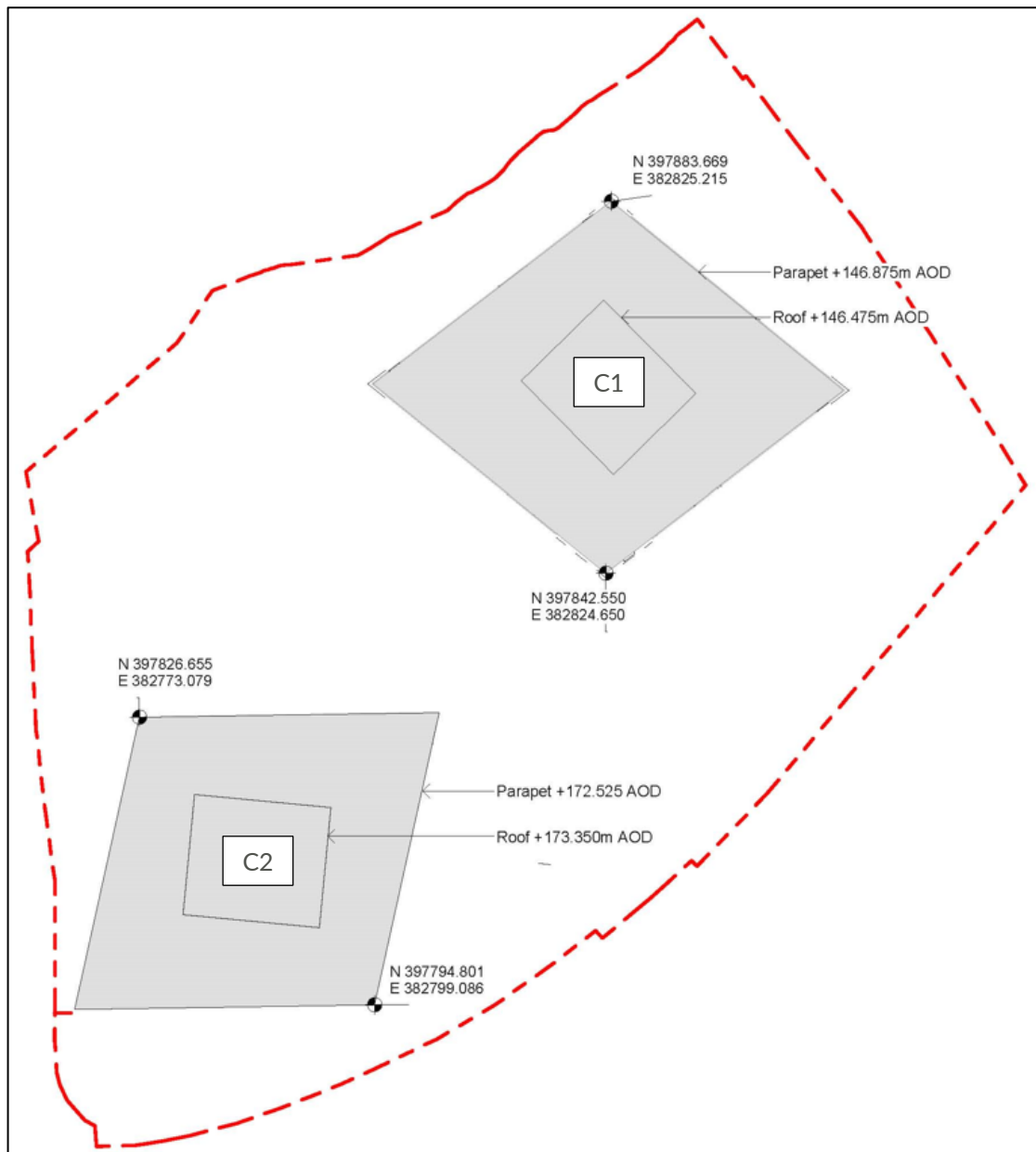


Figure 4 Proposed development footprint – Towers C1 and C2

<sup>8</sup> Source: Simpsonhaugh (cropped).

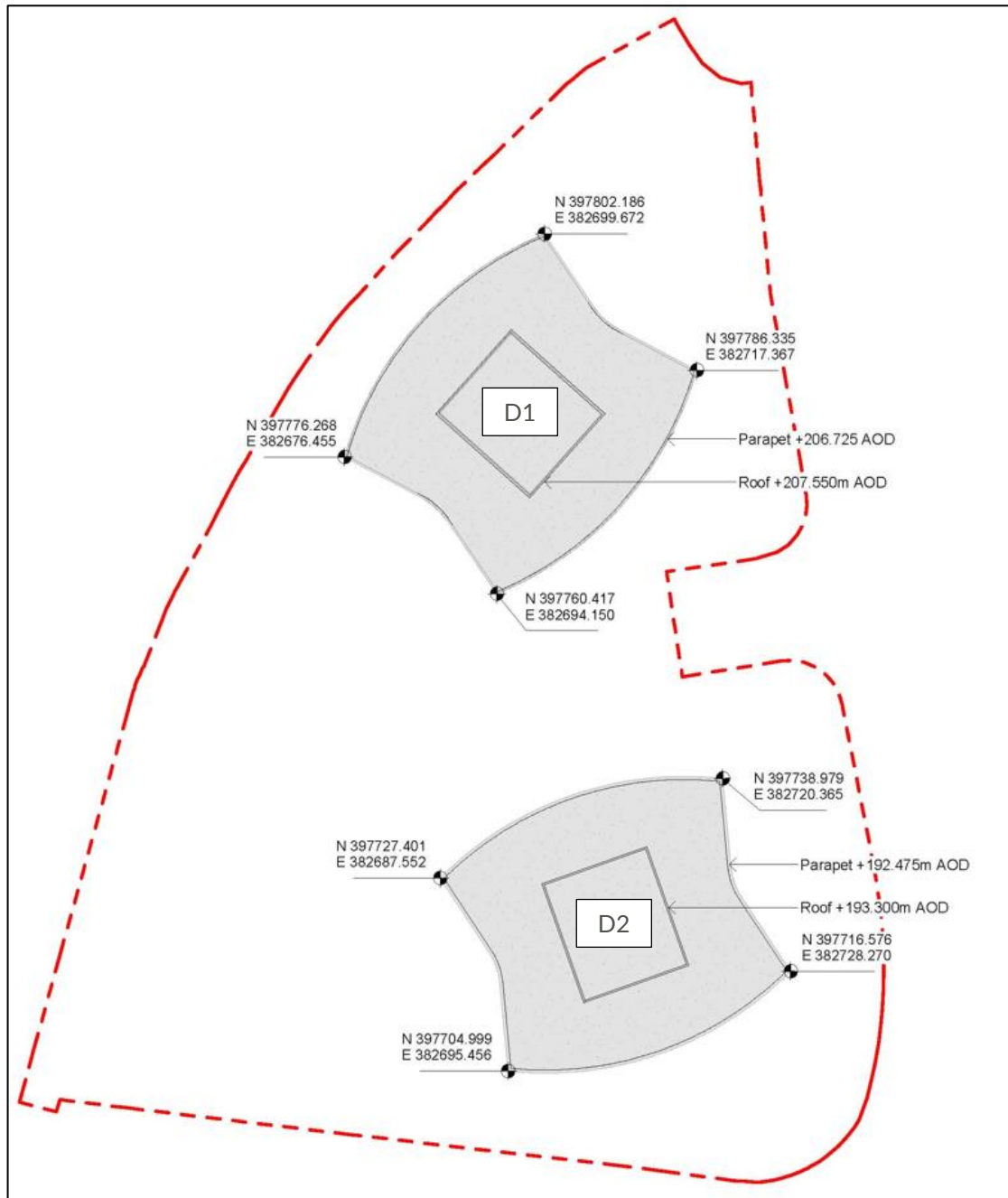


Figure 5 Proposed development footprint – Towers D1 and D2

## 2.7 Proposed Development 3D Representation

Figure 6<sup>9</sup> below shows the 3D representation of the proposed developments. The image is aligned approximately west.

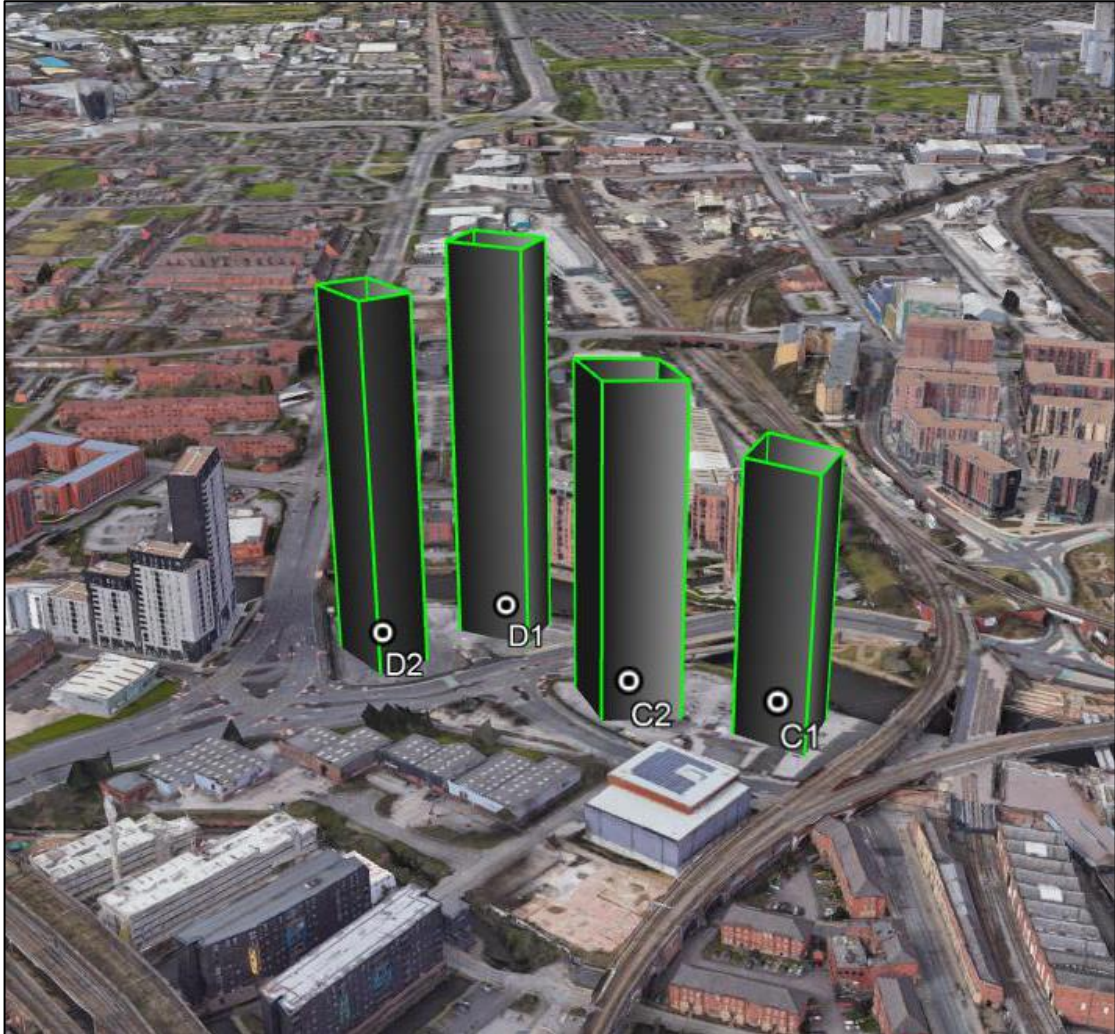


Figure 6 Proposed development 3D representation

---

<sup>9</sup> Source: Simpsonhaugh (cropped).

## 3 GUIDANCE REVIEW

### 3.1 Overview

The following section presents a review of the relevant aviation lighting guidance.

### 3.2 Air Navigation Order: Article 219 – Overview

The following presents Article 219 of the Air Navigation Order<sup>10</sup>. Key points relating to design of the lighting scheme are underlined.

#### *Lighting of en-route obstacles*

*219. – (1) The person in charge of an en-route obstacle must ensure that it is fitted with medium intensity steady red lights positioned as close as possible to the top of the obstacle and at intermediate levels spaced so far as practicable equally between the top lights and ground level with an interval of not more than 52 metres.*

*(2) The person in charge of an en-route obstacle must, subject to paragraph (3), ensure that by night the lights required to be fitted by this article are displayed.*

*(3) In the event of the failure of any light which is required by this article to be displayed by night the person in charge must repair or replace the light as soon as reasonably practicable.*

*(4) At each level on the obstacle where lights are required to be fitted, sufficient lights must be fitted and arranged so as to show when displayed in all directions.*

*(5) In any particular case the CAA may direct that an en-route obstacle must be fitted with and must display such additional lights in such positions and at such times as it may specify.*

*(6) A permission may be granted for the purposes of this article for a particular case or class of cases or generally.*

*(7) This article does not apply to any en-route obstacle for which the CAA has granted a permission to the person in charge permitting that person not to fit and display lights in accordance with this article.*

*(8) In this article, an 'en-route obstacle' means any building, structure or erection, the height of which is 150 metres or more above ground level, but it does not include a building, structure or erection—*

*(a) which is in the vicinity of a licensed aerodrome; and*

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<sup>10</sup> Source: 2009 No. 3015 Civil Aviation. The Air Navigation Order 2009. Last accessed 18/08/2021.

(b) to which section 47 of the Civil Aviation Act 1982(a) (warning of presence of obstructions near licensed aerodromes) applies.

### 3.2.1 Key Points

The key points presented within the guidance are discussed within Table 2 below.

| Section  | Comments and Discussion                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 219. (1) | It is stated that en-route obstacles should be lit with 'medium intensity steady red lights' as close to the top as possible, in addition to intermediate lighting at no bigger distance than 52 metres between each light. The term 'en-route' is open to interpretation however it would be understood to be a development outside of an airport's controlled airspace and outside of its obstacle limitation surfaces.                                                                                                                                                                                                                            |
| 219. (4) | It is stated that all lights should be visible from all directions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 219. (8) | It is stated that an 'en-route obstacle' means any building 150m agl or more excluding those 'in the vicinity' of a licensed aerodrome or where section 47 applies. In relation to the Trinity Islands development:<br><br>The development may be considered an en-route obstacle because two towers (D1 and D2) are above 150m agl however the term 'vicinity' is not defined by a set distance. As the proposed development lies entirely within Manchester Airport's controlled airspace and within the bounds of its OLS, the proposed development could be considered to be in the vicinity of Manchester Airport and therefore not 'en-route'. |

Table 2 ANO 219 comments and discussion

### 3.3 European Aviation Safety Agency<sup>11</sup>: Certification Specifications and Guidance Material for Aerodrome Design<sup>12</sup> – Overview

The following text is taken from the relevant sections of the EASA CS-ADR-DSN<sup>13</sup> document. Key points relating to design of the lighting scheme are underlined.

#### CHAPTER Q – VISUAL AIDS FOR DENOTING OBSTACLES

##### **CS ADR-DSN.Q.840 Objects to be marked and/or lighted within the lateral boundaries of the obstacle limitation surfaces**

*(a) Applicability: The specifications for objects to be marked and/or lighted within the lateral boundaries of the obstacle limitation surfaces apply only to the area under control of the aerodrome operator.*

*(b) Elevated aeronautical ground lights within the movement area should be marked so as to be conspicuous by day. Obstacle lights should not be installed on elevated ground lights or signs in the movement area.*

*(c) All obstacles within the distance specified in Table D-1, column (11), (12) or (13), from the centre line of a taxiway, an apron taxiway or aircraft stand taxilane should be marked and, if the taxiway, apron taxiway or aircraft stand taxilane is used at night, lighted.*

*(d) A fixed obstacle that extends above a take-off climb, approach or transitional surface within 3 000 m of the inner edge of the take-off climb or approach surface should be marked and if the runway is used at night, lighted, except that:*

*(1) such marking and lighting may be omitted when the obstacle is shielded by another fixed obstacle;*

*(2) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day, and its height above the level of the surrounding ground does not exceed 150 m;*

*(3) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day if medium intensity lights, Type A, are deemed insufficient; and*

*(4) the lighting may be omitted where the obstacle is a lighthouse and an safety assessment indicates the lighthouse light to be sufficient.*

*(e) A fixed object, other than an obstacle, adjacent to a take-off climb, approach or transitional surface should be marked and, if the runway is used at night, lighted, if such marking and lighting is considered necessary to ensure its avoidance, except that the marking may be omitted when:*

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<sup>11</sup> EASA.

<sup>12</sup> CS-ADR-DSN.

<sup>13</sup> European Aviation Safety Agency, Certification Specifications and Guidance Material for Aerodromes Design. Issue 4, 13 December 2017. Last accessed 18/08/2021.

- (1) the object is lighted by medium-intensity obstacle lights, Type A, by day, and its height above the level of the surrounding ground does not exceed 150 m; or
- (2) the object is lighted by high-intensity obstacle lights by day if medium intensity lights, Type A, are deemed insufficient.

(f) A fixed obstacle that extends above a horizontal surface should be marked and if the aerodrome is used at night, lighted, except that:

- (1) such marking and lighting may be omitted when:
  - (i) the obstacle is shielded by another fixed obstacle; or
  - (ii) for a circuit extensively obstructed by immovable objects or terrain, procedures have been established to ensure safe vertical clearance below prescribed flight paths; or
  - (iii) a safety assessment shows the obstacle is not of operational significance.
- (2) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day, and its height above the level of the surrounding ground does not exceed 150 m;
- (3) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day if medium intensity lights, Type A, are deemed insufficient; and
- (4) the lighting may be omitted where the obstacle is a lighthouse and a safety assessment indicates the lighthouse light to be sufficient.

(g) A fixed object that extends above an obstacle protection surface should be marked and, if the runway is used at night, lighted, except that such marking and lighting may be omitted when the obstacle is shielded by another fixed obstacle.

[Issue: ADR-DSN/3]

**CS ADR-DSN.Q.841 Objects to be marked and/or lighted outside the lateral boundaries of the obstacle limitation surfaces**

- (a) Applicability: The specifications for objects to be marked and/or lighted outside the lateral boundaries of the obstacle limitation surfaces apply only to the area under control of the aerodrome operator.
- (b) Obstacles in accordance with CS ADR-DSN.J.487 should be marked and lighted, except that the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day.
- (c) When considered as an obstacle, other objects outside the obstacle limitation surfaces should be marked and/or lighted.

[Issue: ADR-DSN/3]

(No Q.842-844 present within the guidance. CS ADR-DSN.Q.845 omitted)

## CHAPTER Q – VISUAL AIDS FOR DENOTING OBSTACLES

### CS ADR-DSN.Q.846 Lighting of fixed objects

(a) The presence of objects which should be lighted, as specified in CS ADR-DSN.Q.840 and CS ADR-DSN.Q.841 should be indicated by low-, medium- or high-intensity obstacle lights, or a combination of such lights.

(b) Low-intensity obstacle lights, Types A, B, C and D, medium-intensity obstacle lights, Types A, B and C and high-intensity obstacle lights Types A and B, should be in accordance with the specifications in Table Q-1, CS ADR-DSN.U.930 and Figure U-1A or U-1B, as appropriate.

(c) The number and arrangement of low-, medium- or high-intensity obstacle lights at each level to be marked should be such that the object is indicated from every angle in azimuth. Where a light is shielded in any direction by another part of the object or by an adjacent object, additional lights should be provided on that adjacent object, or the part of the object that is shielding the light, in such a way as to retain the general definition of the object to be lighted. If the shielded light does not contribute to the definition of the object to be lighted, it may be omitted.

(d) In case of an object to be lighted one or more low-, medium- or high-intensity obstacle lights should be located as close as practicable to the top of the object.

(e) In the case of chimney or other structure of like function, the top lights should be placed sufficiently below the top so as to minimise contamination by smoke, etc. (see Figure Q-2)<sup>14</sup>.

(f) In the case of a tower or antenna structure indicated by high-intensity obstacle lights by day with an appurtenance such as a rod or an antenna greater than 12 m where it is not practicable to locate a high-intensity obstacle light on the top of the appurtenance, such a light should be located at the highest practicable point, and, if practicable, a medium-intensity obstacle light, Type A, mounted on the top.

(g) In the case of an extensive object or of a group of closely spaced objects to be lighted that are:

(1) Penetrating a horizontal obstacle limitation surface (OLS) or located outside an OLS, the top lights should be so arranged as to at least indicate the points or edges of the object highest in relation to OLS or above the ground, and so as to indicate the general definition and the extent of the objects; and

(2) Penetrating a sloping OLS, the top lights should be so arranged as to at least indicate the points or edges of the object highest in relation to the OLS, and so as to indicate the general definition and the extent of the objects. If two or more edges are of the same height, the edge nearest the landing area should be marked.

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<sup>14</sup> Not presented.

(h) When the obstacle limitation surface concerned is sloping and the highest point above the obstacle limitation surface is not the highest point of the object, additional obstacle lights should be placed on the highest point of the object.

(i) Where lights are applied to display the general definition of an extensive object or a group of closely spaced objects, and

(1) Low-intensity lights are used, they should be spaced at longitudinal intervals not exceeding 45 m.

(2) Medium-intensity lights are used, they should be spaced at longitudinal intervals not exceeding 900 m.

(j) High-intensity obstacle lights, Type A, and medium-intensity obstacle lights, Types A and B, located on an object should flash simultaneously.

(k) The installation setting angles for high-intensity obstacle lights, Type A, should be in accordance with Table Q-5.

[Issue: ADR-DSN/3]

[Issue: ADR-DSN/4]

**(CS ADR-DSN.Q.847 omitted)**

**CS ADR-DSN.Q.848 Lighting of fixed objects with a height 45 m to a height less than 150 m above ground level**

(a) Medium-intensity obstacle lights, Type A, B, or C, should be used where the object is an extensive one. Medium-intensity obstacle lights, Types A and C, should be used alone, whereas medium intensity obstacle lights, Type B, should be used either alone or in combination with low-intensity obstacle lights, Type B.

(b) Where an object is indicated by medium-intensity obstacle lights, Type A, and the top of the object is more than 105 m above the level of the surrounding ground, or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights should be provided at intermediate levels. These additional intermediate lights should be spaced, as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings as appropriate, with the spacing not exceeding 105 m.

(c) Where an object is indicated by medium-intensity obstacle lights, Type B, and the top of the object is more than 45 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights should be provided at intermediate levels. These additional intermediate lights should be alternately low intensity obstacle lights, Type B, and medium-intensity obstacle lights, Type B, and should be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings as appropriate, with the spacing not exceeding 52 m.

(d) Where an object is indicated by medium-intensity obstacle lights, Type C, and the top of the object is more than 45 m above the level of the surrounding ground or the elevation of tops of

nearby buildings (when the object to be marked is surrounded by buildings), additional lights should be provided at intermediate levels. These additional intermediate lights should be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

(e) Where high-intensity obstacle lights, Type A, are used, they should be spaced at uniform intervals not exceeding 105 m between the ground level and the top light(s) specified in paragraph CS ADR-DSN.Q.846(d), except that where an object to be marked is surrounded by buildings, the elevation of the tops of the buildings may be used as the equivalent of the ground level when determining the number of light levels.

[Issue: ADR-DSN/3]

#### **CS ADR-DSN.Q.849 Lighting of fixed objects with a height 150 m or more above ground level**

(a) High-intensity obstacle lights, Type A, should be used to indicate the presence of an object if its height above the level of the surrounding ground exceeds 150 m and a safety assessment indicates such lights to be essential for the recognition of the object by day.

(b) Where high-intensity obstacle lights, Type A, are used, they should be spaced at uniform intervals not exceeding 105 m between the ground level and the top light(s) specified in CS ADR-DSN.Q.846(d), except where an object to be marked is surrounded by buildings, the elevation of the tops of the buildings may be used as the equivalent of the ground level when determining the number of light levels.

(c) Where an object is indicated by medium-intensity obstacle lights, Type A, additional lights should be provided at intermediate levels. These additional intermediate lights should be spaced, as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 105 m.

(d) Where an object is indicated by medium-intensity obstacle lights, Type B, additional lights should be provided at intermediate levels. These additional intermediate lights should be alternately low-intensity obstacle lights, Type B, and medium-intensity obstacle lights, Type B, and should be spaced, as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

(e) Where an object is indicated by medium-intensity obstacle lights, Type C, additional lights should be provided at intermediate levels. These additional intermediate lights should be spaced, as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

[Issue: ADR-DSN/3]

...

Tables 3-6 presented below and on the following page are taken from the document and pertain to the text on the previous pages.

| 1                                                                                                                                          | 2                  | 3                            | 4                                                        | 5                                        | 6                                      | 7                              |
|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------------------|----------------------------------------------------------|------------------------------------------|----------------------------------------|--------------------------------|
| Light type                                                                                                                                 | Colour             | Signal type/<br>(Flash Rate) | Peak intensity (cd) at given Background<br>Luminance (b) |                                          |                                        | Light<br>Distribution<br>Table |
|                                                                                                                                            |                    |                              | Day (Above<br>500 cd/m <sup>2</sup> )                    | Twilight (50-<br>500 cd/m <sup>2</sup> ) | Night (Below<br>50 cd/m <sup>2</sup> ) |                                |
| Low-intensity<br>Type A (fixed<br>obstacle)                                                                                                | Red                | Fixed                        | N/A                                                      | N/A                                      | 10                                     | Table Q-2                      |
| Low-intensity<br>Type B (fixed<br>obstacle)                                                                                                | Red                | Fixed                        | N/A                                                      | N/A                                      | 32                                     | Table Q-2                      |
| Low-intensity<br>Type C (mobile<br>obstacle)                                                                                               | Yellow/Blue<br>(a) | Flashing<br>(60-90 fpm)      | N/A                                                      | 40                                       | 40                                     | Table Q-2                      |
| Low-intensity<br>Type D (follow-<br>me vehicle)                                                                                            | Yellow             | Flashing<br>(60-90 fpm)      | N/A                                                      | 200                                      | 200                                    | Table Q-2                      |
| Low-intensity,<br>Type E                                                                                                                   | Red                | Flashing<br>(c)              | N/A                                                      | N/A                                      | 32                                     | Table Q-2<br>(Type B)          |
| Medium-<br>intensity Type A                                                                                                                | White              | Flashing<br>(20-60 fpm)      | 20 000                                                   | 20 000                                   | 2 000                                  | Table Q-3                      |
| Medium-<br>intensity Type B                                                                                                                | Red                | Flashing<br>(20-60 fpm)      | N/A                                                      | N/A                                      | 2 000                                  | Table Q-3                      |
| Medium-<br>intensity Type C                                                                                                                | Red                | Fixed                        | N/A                                                      | N/A                                      | 2 000                                  | Table Q-3                      |
| High-intensity<br>Type A                                                                                                                   | White              | Flashing<br>(40-60 fpm)      | 200 000                                                  | 20 000                                   | 2 000                                  | Table Q-3                      |
| High-intensity<br>Type B                                                                                                                   | White              | Flashing<br>(40-60 fpm)      | 100 000                                                  | 20 000                                   | 2 000                                  | Table Q-3                      |
| (a) CS ADR-DSN.Q.850(b)                                                                                                                    |                    |                              |                                                          |                                          |                                        |                                |
| (b) For flashing lights, effective intensity as determined in accordance with ICAO Doc 9157, Aerodrome Design Manual, Part 4, Visual Aids. |                    |                              |                                                          |                                          |                                        |                                |
| (c) For wind turbine application, to flash at the same rate as the lighting on the nacelle.                                                |                    |                              |                                                          |                                          |                                        |                                |

Table 3 Table Q-1. Characteristics of obstacle lights

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Minimum intensity<br>(a) | Maximum intensity<br>(a) | Vertical beam spread<br>(f) |           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|-----------------------------|-----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                          |                          | Minimum beam spread         | Intensity |
| Type A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 10 cd (b)                | N/A                      | 10°                         | 5 cd      |
| Type B                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 32 cd (b)                | N/A                      | 10°                         | 16 cd     |
| Type C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 40 cd (b)                | 400 cd                   | 12(d)                       | 20 cd     |
| Type D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 200 cd (c)               | 400 cd                   | N/A(e)                      | N/A       |
| <p>Note: This table does not include recommended horizontal beam spreads. CS ADR-DSN.Q.846(c) requires 360° coverage around an obstacle. Therefore, the number of lights needed to meet this requirement will depend on the horizontal beam spreads of each light as well as the shape of the obstacle. Thus, with narrower beam spreads, more lights will be required.</p> <p>(a) 360° horizontal. For flashing lights, the intensity is read into effective intensity, as determined in accordance with ICAO, Aerodrome Design Manual, Part 4, Visual Aids.</p> <p>(b) Between 2 and 10° vertical. Elevation vertical angles are referenced to the horizontal when the light is levelled.</p> <p>(c) Between 2 and 20° vertical. Elevation vertical angles are referenced to the horizontal when the light is levelled.</p> <p>(d) Peak intensity should be located at approximately 2.5° vertical.</p> <p>(e) Peak intensity should be located at approximately 17° vertical.</p> <p>(f) Beam spread is defined as the angle between the horizontal plan and the directions for which the intensity exceeds that mentioned in the 'intensity' column.</p> |                          |                          |                             |           |

Table 4 Table Q-2. Light distribution for low-intensity obstacle lights

| Benchmark intensity | Minimum requirements          |                       |                       |                          |               | Recommendations              |                       |                       |                          |               |
|---------------------|-------------------------------|-----------------------|-----------------------|--------------------------|---------------|------------------------------|-----------------------|-----------------------|--------------------------|---------------|
|                     | Vertical elevation angle (b)  |                       |                       | Vertical beam spread (c) |               | Vertical elevation angle (b) |                       |                       | Vertical beam spread (c) |               |
|                     | 0°                            |                       | -1°                   |                          |               | 0°                           | -1°                   | -10°                  |                          |               |
|                     | Minimum average intensity (a) | Minimum intensity (a) | Minimum intensity (a) | Minimum beam spread      | Intensity (a) | Maximum intensity (a)        | Maximum intensity (a) | Maximum intensity (a) | Maximum beam spread      | Intensity (a) |
| 200 000             | 200 000                       | 150 000               | 75 000                | 3°                       | 75 000        | 250 000                      | 112 500               | 7 500                 | 7°                       | 75 000        |
| 100 000             | 100 000                       | 75 000                | 37 500                | 3°                       | 37 500        | 125 000                      | 56 250                | 3 750                 | 7°                       | 37 500        |
| 20 000              | 20 000                        | 15 000                | 7 500                 | 3°                       | 7 500         | 25 000                       | 11 250                | 750                   | N/A                      | N/A           |
| 2 000               | 2 000                         | 1 500                 | 750                   | 3°                       | 750           | 2 500                        | 1 125                 | 75                    | N/A                      | N/A           |

Note: This table does not include recommended horizontal beam spreads. CS ADR-DSN.Q.846(c) requires 360° coverage around an obstacle. Therefore, the number of lights needed to meet this requirement will depend on the horizontal beam spreads of each light as well as the shape of the obstacle. Thus, with narrower beam spreads, more lights will be required.

(a) 360° horizontal. All intensities are expressed in Candela. For flashing lights, the intensity is read into effective intensity, as determined in accordance with ICAO Doc 9157, Aerodrome Design Manual, Part 4, Visual Aids.

(b) Elevation vertical angles are referenced to the horizontal when the light unit is levelled.

(c) Beam spread is defined as the angle between the horizontal plan and the directions for which the intensity exceeds that mentioned in the 'intensity' column.

Note: an extended beam spread may be necessary under specific configuration and justified by an aeronautical study.

Table 5 Table Q-3. Light distribution for medium- and high-intensity obstacle lights according to benchmark intensities in Q-1.

| Height of light unit above terrain (AGL) |               | Angle of the peak of the beam above the horizontal |
|------------------------------------------|---------------|----------------------------------------------------|
| Greater than                             | Not exceeding |                                                    |
| 151 m                                    |               | 0°                                                 |
| 122 m                                    | 151 m         | 1°                                                 |
| 92 m                                     | 122 m         | 2°                                                 |
|                                          | 92 m          | 3°                                                 |

Table 6 Table Q-5. Installation setting angle for high intensity obstacle lights

### 3.3.1 Key Points

The key points presented within the guidance are discussed within Table 7 below.

| Section   | Comments and Discussion                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Q.840 (a) | The development is within controlled airspace managed by Manchester Airport. One of the four towers infringe upon the obstacle limitation surfaces (D1) the outer horizontal surface) as defined within the EASA guidance however both D1 and D2 extend to 150m agl and above. The remaining towers (C1 and C2) do not infringe the obstacle limitation surfaces and are below 150m agl.                              |
| Q.841 (c) | It states that obstacles outside the obstacle limitation surfaces should be lit if they are deemed to be obstacles.<br><br>The proposed development is deemed to be an obstacle as it is within Manchester Airport's controlled airspace, with one towers (D1) infringing the OLS and measuring to 150m agl or higher (D1 and D2).<br><br>Towers C1 and C2 are not deemed to be obstacles.                            |
| Q.846 (c) | The number and arrangement of obstacle lights at each level should be marked such that the object is indicated from every angle in azimuth. Where a light is shielded, additional lights should be provided on that object in such a way as to retain the general definition of the object to be lighted. If the shielded light does not contribute to the definition of the object to be lighted, it may be omitted. |
| Q.846 (d) | In case of an object to be lighted one or more low-, medium- or high-intensity obstacle lights should be located as close as practicable to the top of the object.                                                                                                                                                                                                                                                    |
| Q.849 (e) | Medium intensity Type C 2000 candela lights is the standard aviation lighting specification in Manchester. Intermediate lights are however not always implemented. Discussed further in Section 4.2.                                                                                                                                                                                                                  |
| Table Q-1 | The characteristics of medium-intensity Type C lights are fixed red at 2,000 candela. The light distribution should be in accordance with Table Q-3.                                                                                                                                                                                                                                                                  |

Table 7 EASA CS-ADR-DSN comments and discussion

### 3.4 CAP 168: Licensing of Aerodromes – Overview

The following text is taken from the relevant sections of CAP 168<sup>15</sup>. Some paragraphs have been omitted due to reference to wind turbines, masts etc. Key points relating to design of the lighting scheme are underlined.

#### **Chapter 4 The assessment and treatment of obstacles**

##### **Marking and lighting of obstacles and unserviceable surface areas**

###### **General**

4.74 All objects which extend to a height of 150 m or more above ground elevation are regarded as obstacles and shall be lit in accordance with ANO Article 219. Other objects of a lesser height may be assessed as hazards to aviation and also treated as obstacles. They should be marked and/or lit as detailed in the following paragraphs.

###### **Objects to be marked or lit**

4.76 Objects which are deemed by the CAA to be en route obstacles should be marked and/or lit.

4.77 Other objects inside (and outside) the obstacle limitation surfaces should be marked and/or lighted if an aeronautical study indicates that they could constitute a hazard to aircraft (this includes adjacent to visual routes, e.g. waterways, or highways). Wind turbines, whether on, near or away from the immediate vicinity of an aerodrome, which are deemed to be obstacles, should be marked and/or lit accordingly.

###### **Lighting of obstacles**

4.101 Obstacle lights should be used to indicate the existence of objects which are to be lit as follows:

1. Low intensity steady red obstacle lights should be used on obstacles less than 45 m high, except that medium intensity steady red lights should be used to light such obstacles as an elongated structure, an obstacle in the outer area of the approach or high ground adjacent to the aerodrome circuit. There are two types of low intensity obstacle lights for fixed obstacles:

Group A and Group B (see table 6A.1).

a) Low intensity Group A lights should be used for obstacles on the movement area where Group B lights may cause dazzle.

b) Low intensity Group B lights should be used away from the movement area or in areas on the movement area with high levels of background illuminance.

2. Medium intensity red steady obstacle lights should be used on obstacles between 45 m and less than 150 m in height.

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<sup>15</sup> CAP 168 Licensing of Aerodromes, Edition 11, January 2019. Last accessed 18/08/2021.

3. Medium intensity steady red obstacle lights should be used to indicate the presence of:

a) an obstacle if its height is 150 m or more; or

b) a tower supporting overhead wires, cables etc. of any height where an aeronautical study indicates such lights to be essential for recognition of the presence of the obstacle.

4.102 However, where an aeronautical study conducted by the CAA concludes that greater conspicuity of the obstacle through the use of a higher specification light is required, the use of a high intensity flashing white obstacle light will be considered by the CAA.

**Location of obstacle lights (figure 4.18)** (presented in Figure 7 on the following page)

4.104 The top light

1. Except in the case of a chimney or other similar structure, one or more lights should be located at the top of the obstacle. The lights should be so arranged as to indicate the highest points or edges of the obstacle relative to the obstacle limitation surface. If two or more edges are of the same height, the edge nearest the flight path should be lit. On facing sides of groups of obstacles, lights may be omitted with the approval of the CAA, and the group treated as one solid obstacle.

**Intermediate lights**

4.105 Where the top of an obstacle is more than 45 m above the level of the surrounding ground, additional lights should be provided at intermediate levels. These additional lights should be spaced as equally as practicable between the top light and ground level as follows:

1. when low or medium intensity obstacle lights are used the spacing should not exceed 52 m;

...

4. at each level the lights should be arranged to give full cover in azimuth.

**Low intensity obstacle lights**

4.115 On fixed obstacles, low intensity lights should be steady red and omnidirectional.

**Medium intensity obstacle lights**

4.116 Medium intensity obstacle lights should be steady red light.

**Figure 4.18 Lighting of objects**

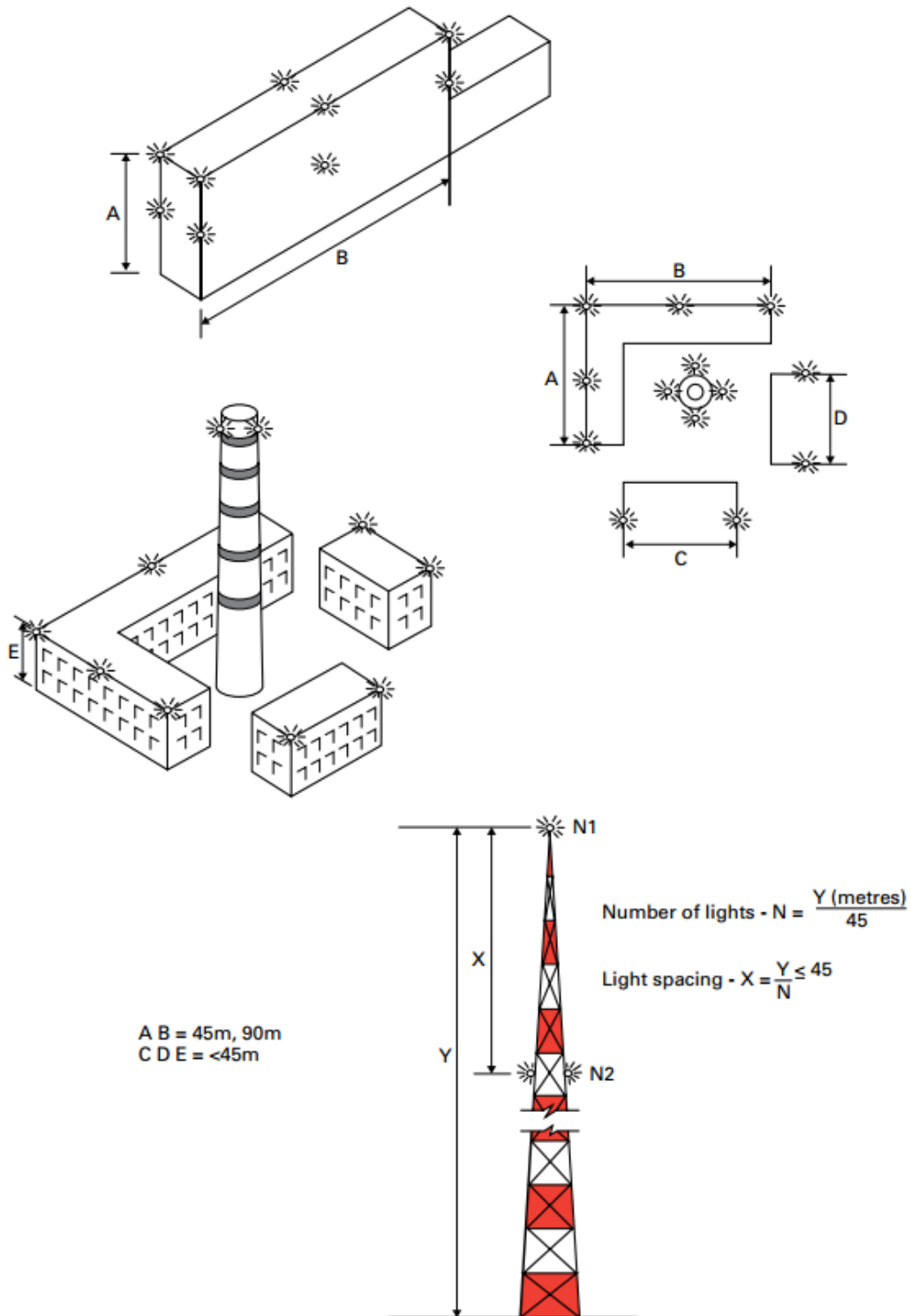


Figure 7 Figure 4.18 from CAP 168 – Lighting of Objects

### 3.4.1 Key Points

The key points presented within the guidance are discussed within Table 8 below.

| Section                | Comments and Discussion                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Chapter 4<br>4.74      | Cap 168 (in accordance with ANO Article 219) states that objects 150m agl or more should be lit. Those less than 150m agl could still require lighting if it is deemed a potential hazard to safety.<br><br>The development will require lighting on two towers (D1 and D2) because they are 150m agl or more (in accordance with CAP 168). The remaining towers (C1 and C2) do not need to be lit. |
| Chapter 4<br>4.77      | Objects should be lit if deemed to be a hazard to aviation safety.                                                                                                                                                                                                                                                                                                                                  |
| Chapter 4<br>4.101 - 3 | Medium intensity steady red obstacle lights should be used to indicate the presence of an obstacle if its height is 150m or more.<br><br>Medium intensity lights would be required on towers D1 and D2.                                                                                                                                                                                             |
| Chapter 4<br>4.104 - 1 | The lights should be so arranged as to indicate the highest points or edges of the obstacle relative to the obstacle limitation surface. If two or more edges are of the same height, the edge nearest the flight path should be lit.                                                                                                                                                               |
| Chapter 4<br>4.105 - 1 | The guidance states that intermediate lighting is required for obstacles that extend 45m above surrounding objects, and should be spaced as equally as practicable with no more than 52m in vertical spacing.<br><br>Intermediate lighting may however not be required considering the development's location within an already well lit area and precedence in this area.                          |
| Chapter 4<br>4.105 - 4 | Each intermediate light, if required, should be arranged to give lighting coverage to the full azimuth range.                                                                                                                                                                                                                                                                                       |
| Chapter 4<br>4.116     | The guidance states that medium intensity obstacle lights should be steady red.                                                                                                                                                                                                                                                                                                                     |

Table 8 CAP 168 comments and discussion

### 3.5 Guidance Discussion

Each guidance states that an en-route obstacle means an object that is 150m agl or more and not in the vicinity of a licensed aerodrome. The development is considered an en-route obstacle in that it is more than 150m agl however it is within the controlled airspace of Manchester Airport and within the bounds of its OLS (with two infringements). Overall, the proposed development is not considered an en-route obstacle.

Based on the review of the guidance, the proposed development requires aviation lighting. A suitable lighting scheme as therefore been proposed.

## 4 PROPOSED LIGHTING SCHEME DESIGN

### 4.1 Overview

A lighting scheme has been designed based on the available guidance, specifically within ANO 219 and EASA CS-ADR-DSN. The recommended lighting scheme, along with the rationale, is presented in the following sub-section.

### 4.2 Precedence

The precedence for the aviation lighting for a select number of building developments in Manchester which are consented, under construction and operational is presented in the following sub-sections.

#### 4.2.1 Deansgate Square

The lighting scheme for the two tallest towers of the Deansgate Square development (both over 150m agl) which is currently under construction/operational is presented in Table 9 below.

| Building                                                 | Approx. Height agl | Type of Light                                          | Number of Lights | Positioning of Lighting                                         |
|----------------------------------------------------------|--------------------|--------------------------------------------------------|------------------|-----------------------------------------------------------------|
| Deansgate Square North Tower                             | 197.55m            | Main lights = Medium-intensity steady red (Type C) LED | 4                | Unobstructed positions on all four corners of the tower's roof. |
|                                                          |                    | No intermediate lights                                 | -                | Lighting scheme was accepted with no intermediate lighting.     |
| Deansgate Square East Tower                              | 157.70m            | Main lights = Medium-intensity steady red (Type C) LED | 4                | Unobstructed positions on all four corners of the tower's roof. |
|                                                          |                    | No intermediate lights                                 | -                | Lighting scheme was accepted with no intermediate lighting.     |
| Lights are illuminated continuously and omnidirectional. |                    |                                                        |                  |                                                                 |

Table 9 Deansgate Square lighting scheme

The Deansgate Square development has no intermediate lighting.

#### 4.2.2 Crown Street Phase 1

The lighting scheme for tower 1 of the Crown Street Phase 1 development (over 150m agl) which is currently under construction is presented in Table 10 below.

| Height agl                                                     | Type of Light                                                                | Number of Lights | Positioning of Lighting / Reason                                |
|----------------------------------------------------------------|------------------------------------------------------------------------------|------------------|-----------------------------------------------------------------|
| 152.4m                                                         | Main lights =<br>Medium-intensity steady red<br>(2,000 candela) (Type C) LED | 4                | Unobstructed positions on all four corners of the tower's roof. |
|                                                                | No intermediate lights                                                       | -                | Lighting scheme was accepted with no intermediate lighting.     |
| Lights are to be illuminated continuously and omnidirectional. |                                                                              |                  |                                                                 |

Table 10 Crown Street Phase 1 lighting scheme

The Crown Street Phase 1 lighting scheme was accepted with no intermediate lighting.

#### 4.2.3 Beetham Tower

The expected<sup>16</sup> lighting scheme for the Beetham Tower (over 150m agl) which is operational is presented in Table 11 below.

| Height agl                                               | Type of Light                                             | Number of Lights | Positioning of Lighting / Reason                                                |
|----------------------------------------------------------|-----------------------------------------------------------|------------------|---------------------------------------------------------------------------------|
| 169m                                                     | Main lights =<br>Appear to be medium-intensity steady red | 4                | Unobstructed positions on all four corners of the tower's roof over two levels. |
|                                                          | Intermediate lights appear present of lower intensity     | 4                | Four intermediate lights appear present.                                        |
| Lights are illuminated continuously and omnidirectional. |                                                           |                  |                                                                                 |

Table 11 Beetham Tower lighting scheme

The Beetham Tower appears to have both medium intensity lights on its roof as well as intermediates lights.

<sup>16</sup> Based on a review of available imagery.

#### 4.2.4 Building Developments in the Surrounding Area

The consented and existing building developments relative to the proposed development are presented in Figures<sup>17</sup> 8 and 9 on the following pages. Each of the key building developments discussed in the previous section are highlighted.

The figures show that the proposed Trinity Islands development will add to an area of tall buildings (Crown Street Phase 1, Deansgate Square and the Beetham Tower). Figure 10 also shows a number of existing smaller buildings immediately surrounding the proposed development which would have a maximum height similar to that of any lower-level intermediate aviation light. In general, this area will be well lit irrespective of any aviation lighted due to internal lighting, its presence in Manchester city centre, and its proximity to the well-lit A57 and A6042.

The towers (at least D1 and D2) will also be highlighted on aviation charts. Low flying aircraft will already be affected by tall buildings with pilots expecting to see tall buildings in the area. The proposed development is also already located in restricted airspace to 1,700ft. Trinity Islands will not affect scheduled aircraft using Manchester Airport. In practice low flying aircraft in the vicinity are likely to be civil helicopters, with the pilots being aware of the presence of the tall buildings in this area.

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<sup>17</sup> Source: Copyright © 2021 Google.

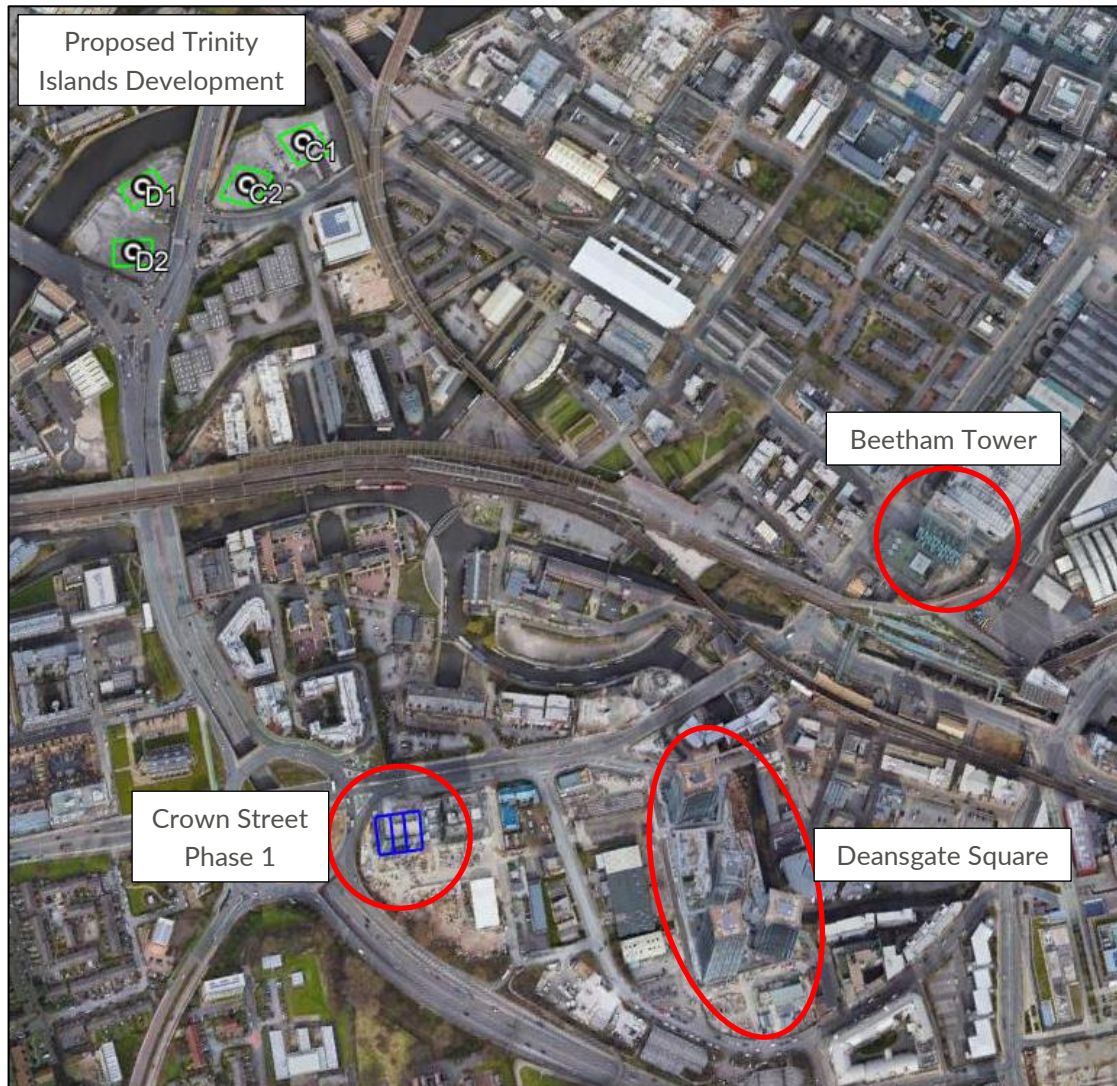


Figure 8 Existing and consented tall buildings in Manchester – aerial imagery (aligned north)

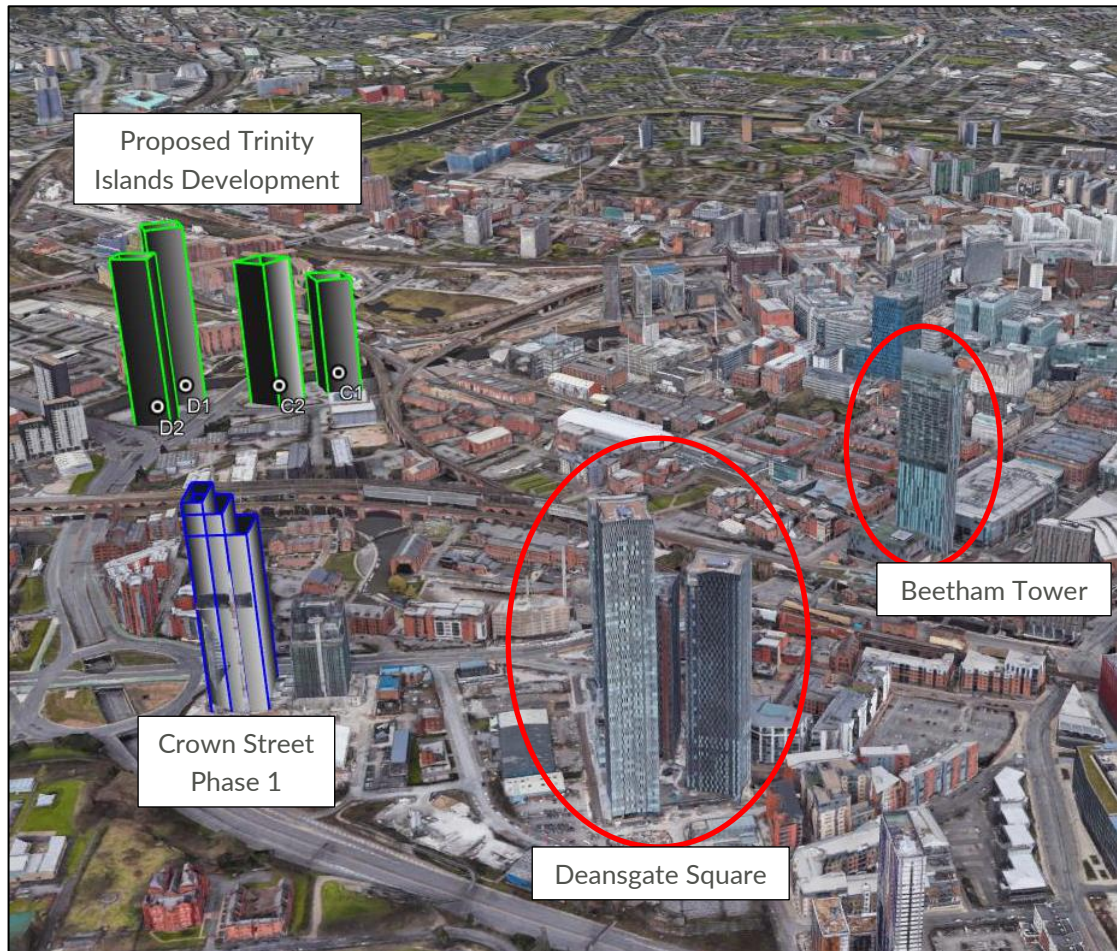


Figure 9 Existing and consented tall buildings in Manchester – 3D aerial imagery (aligned north northwest)



Figure 10 Existing and consented tall buildings in Manchester – 3D aerial imagery (aligned east)

### 4.3 Rationale and Lighting Scheme Design

The following factors influenced the proposed lighting scheme:

1. The height of the development (each tower);
2. The location of the development with respect to the Manchester Airport's OLS and any infringements;
3. The lighting and height of existing structures surrounding the development and in Manchester;
4. Planning and lighting precedence;
5. Consideration of the surrounding environment and airspace.

With respect to the lighting scheme for the proposed development:

1. It is recommended that the towers are lit with aviation lights for aviation safety;
2. There is a precedence that no intermediate lights are required;
3. There is a lot of background city centre lighting;
4. The buildings themselves are likely to be lit;
5. The tall buildings will be marked on aviation charts.

The following is true regarding the proposed development:

- Two of the four towers extend above 150m agl<sup>18</sup> (D1 = 180.150m and D2 = 165.900m agl);
- Two of the four towers do not extend above 150m agl (C1 = 119.475m and C2 = 145.950 agl);
- One of the towers infringes the OHS of Manchester Airport (D1 by 0.8572m);
- Three of the towers do not infringe the OLS (C1, C2 and D2).

On this basis, aviation lighting is mandatory as per the associated CAA guidance and because of the infringement of the OLS (tower D1). The following lighting arrangements are therefore recommended:

- The towers will be lit with medium intensity lights;
- The requirement for intermediate lights on each tower should be discussed with Manchester Airport;
- The towers tower will be marked on CAA Aeronautical Charts.

The specific aviation lighting scheme for each tower is presented in Table 12 on the following page.

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<sup>18</sup> Based on the ground heights provided within the development plans.

| Building                                                       | Height agl     | Type of Light                                        | Number of Lights | Positioning of Lighting / Reason                                                                                                                                                                                                                                                                    |
|----------------------------------------------------------------|----------------|------------------------------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C1                                                             | 119.475 metres | No roof lights                                       | -                | No lighting is required for this tower. It does not extend to 150m agl or above and does not infringe an OLS.                                                                                                                                                                                       |
|                                                                |                | No intermediate lights                               | -                |                                                                                                                                                                                                                                                                                                     |
| C2                                                             | 145.950 metres | No roof lights                                       | -                | No lighting is required for this tower. It does not extend to 150m agl or above and does not infringe an OLS.                                                                                                                                                                                       |
|                                                                |                | No intermediate lights                               | -                |                                                                                                                                                                                                                                                                                                     |
| D1                                                             | 180.150 metres | Medium intensity steady red – 2000 candela (Type C). | 4                | It is recommended that four lights are installed, one on each corner at its edge.<br><br>No intermediate lights are initially recommended considering the surrounding environment, internal lighting and lighting precedent in Manchester however this should be discussed with Manchester Airport. |
|                                                                |                | No intermediate lights.                              | -                |                                                                                                                                                                                                                                                                                                     |
| D2                                                             | 165.900 metres | Medium intensity steady red – 2000 candela (Type C). | 4                | It is recommended that four lights are installed, one on each corner at its edge.<br><br>No intermediate lights are initially recommended considering the surrounding environment, internal lighting and lighting precedent in Manchester however this should be discussed with Manchester Airport. |
|                                                                |                | No intermediate lights.                              | -                |                                                                                                                                                                                                                                                                                                     |
| Lights should be illuminated continuously and omnidirectional. |                |                                                      |                  |                                                                                                                                                                                                                                                                                                     |

Table 12 Recommended lighting scheme

Figures<sup>19</sup> 10 and 11 on the following page shows a top-down and 3D representative image of the proposed development and recommended lighting scheme. The red circles indicate the proposed lighting positions.



Figure 11 Recommended lighting scheme – top-down

<sup>19</sup> Source: Aerial image copyright © 2021 Google.

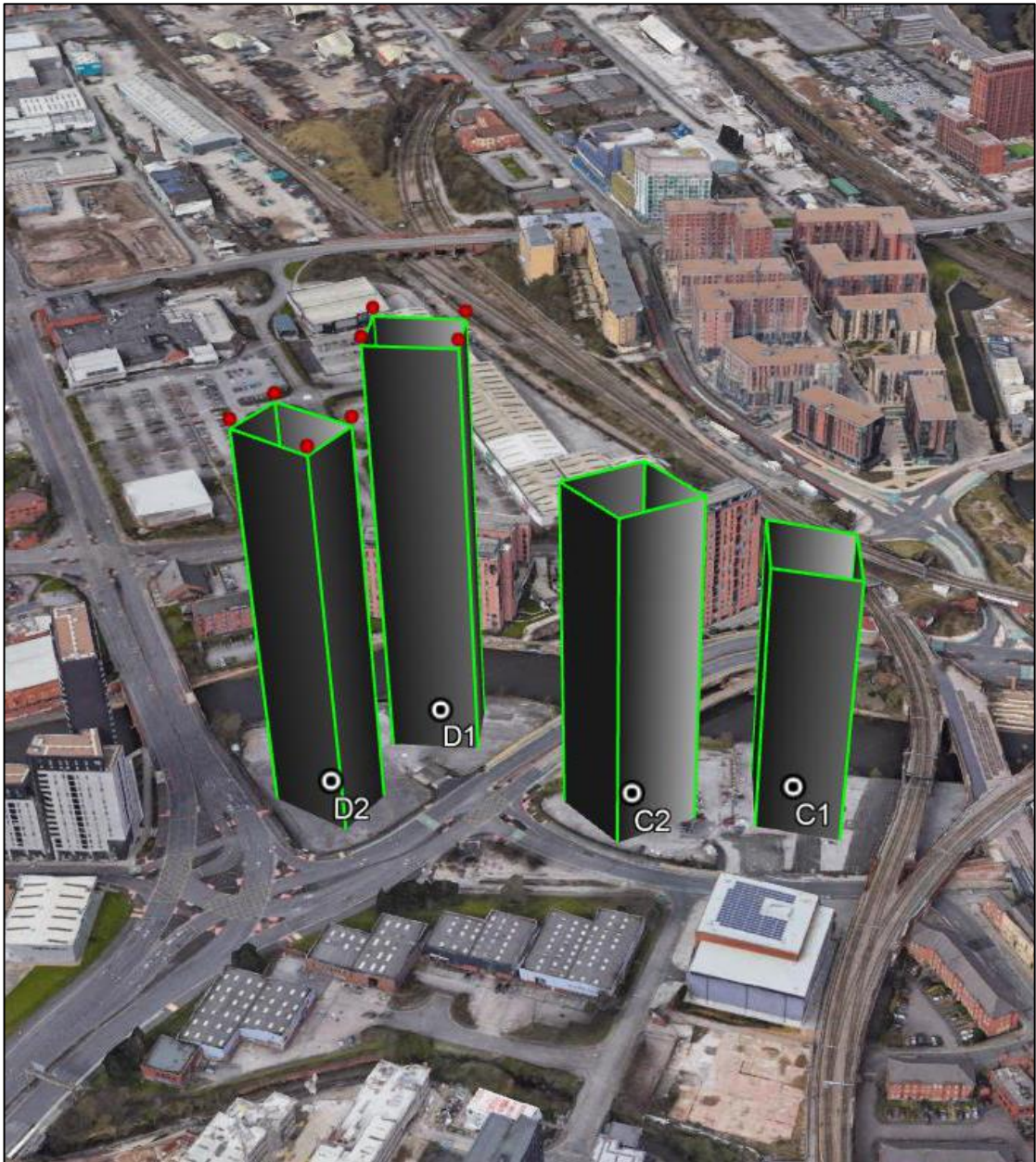


Figure 12 Recommended lighting scheme – representative 3D image

## 5 CONCLUSIONS AND RECOMMENDATIONS

### 5.1 Lighting Scheme Considerations

A lighting scheme for the proposed Trinity Islands development is required due to the location of the towers, safeguarding impacts upon Manchester Airport's OLS and the respective heights of the towers.

The following was completed to determine an overall recommended aviation lighting scheme:

- A review of ANO 219 and EASA CS-ADR-DSN guidance as well as the CAA CAP 168;
- A comparison of the guidance with respect to obstacle lighting;
- OLS assessment results with respect to the proposed development Manchester Airport;
- An examination of the lighting and height of existing structures surrounding the development;
- Planning and lighting precedence;
- Consideration of the surrounding environment.

### 5.2 Lighting Requirement

The following is true regarding the proposed development:

- Two of the four towers extend above 150m agl<sup>20</sup> (D1 = 180.150m and D2 = 165.900m agl);
- Two of the four towers do not extend above 150m agl (C1 = 119.475m and C2 = 145.950 agl);
- One of the towers infringes the OHS of Manchester Airport (D1 by 0.8572m);
- Three of the towers do not infringe the OLS (C1, C2 and D2).

Under the cited guidance aviation lighting is required.

### 5.3 Recommended Lighting Scheme and Next Steps

The lighting scheme proposed includes the addition of four obstacle lights (medium intensity steady red, Type C – 2000 candela) to be fitted on the corners of the roof of towers D1 and D2. Lighting is not required or recommend for towers C1 or C2 due to their height.

No intermediate lights are recommended considering the presence of existing tall buildings near the proposed development, aviation lighting precedence (Deansgate Square, Crown Street Phase 1 and the Beetham Tower) and presence amongst an already built up and well-lit area in the city centre of Manchester. This however should be discussed further with Manchester Airport.

The lighting scheme will be made available to Manchester Airport for their consideration.

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<sup>20</sup> Based on the ground heights provided within the development plans.



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