

Appendix 12.1: Wind Microclimate

Wind Tunnel

The wind tunnel tests were completed in November 2023, in RWDI Anemos Ltd.'s boundary layer wind tunnel facility, in Milton Keynes. This tunnel has an open working section with an effective width of 3.0 m.

An atmospheric boundary layer, representative of the conditions at the Site, was simulated using a turbulence grid and an arrangement of roughness elements distributed over the floor of the wind tunnel.

The boundary layer simulation was calibrated against the variation in mean wind speed and the intensity and scale of the turbulence with height above ground level appropriate to the Site, based on profiles derived using the widely accepted Deaves and Harris log law wind model and a detailed terrain analysis for the area surrounding the Site. This method yields a good approximation of the mean flow and turbulence characteristics and fully meets the requirements of clause NA2.2 'Guidance on design assisted by testing and measurements' from the UK National Annex to BS EN 1991-1-4:2005.

Figure A12.1 presents the variation of mean wind speed, longitudinal turbulence intensity and gust wind speed used in the tests, with the both the target profiles and the upper and lower bounds of the range of profiles over the full range of wind directions. The wind speed profiles are normalised by the mean wind speed at a reference height of 118 m (the approximate maximum height of the Proposed Scheme above the local ground level).

Instrumentation

Measurements of pedestrian level wind speeds were made using instruments known as Irwin probes. These are standard devices for such measurements. The probes consist of a small tube with a pit at its base. The pressure difference between the top of the tube and the pit is calibrated against wind speed. The top of the tube is set at an equivalent full-scale height of 1.5 m to measure wind speeds at pedestrian height. The sampling rate, combined with the wind tunnel running speed and the linear scale of the model, were appropriate to the model scale simulation used.

People subjected to fluctuating or gusty wind conditions will react to either the mean wind strength or to the maximum gust that occurs. For this reason, both the mean and maximum gust speeds were determined for each measurement location. The gust speed was then converted to a gust-equivalent-mean value based on a factor of $1 / 1.85$.

Measurements were made for a full range of wind directions in 22.5° increments. The wind tunnel measurements were recorded as non-dimensional wind speed ratios relative to the wind tunnel reference wind speed.

Wind Tunnel Model

The wind tunnel model of the Proposed Scheme and surrounding area was constructed by RWDI, based on a 3D model, plans and survey information provided by the design team from August to November 2023. The linear scale of the model is 1:300. The model was constructed on a circular baseboard of diameter 2.4 m, centred around the Site's centre.

Proposed deciduous trees were modelled in winter, or bare, format to represent the worst-case season, assuming a species with substantial canopies. Larger existing deciduous trees in and around the Site were also represented in winter form.

Figure A12.2a illustrates the models for existing Site conditions, the Proposed Scheme in the context of existing surrounding conditions and the Proposed Scheme with future surrounding developments. Figure A12.2b shows close-up images of the landscaping modelled, along with a plan. Figure A12.2c shows the locations of the wind speed sensors, with the proposed or existing uses assumed in the assessment.

Wind Climate Statistics

Long-term wind frequency statistics from Manchester Airport, for the period 2001 to 2015, were sorted into annual and seasonal wind speed and directional bins, with data derived for 16 evenly spaced sectors, and a standard statistical probability distribution (Weibull distribution) applied to each data set. The Weibull parameters were corrected to open-country terrain at sea-level and then corrected to apply directly at the Site, taking account of differences in upwind terrain and altitude between the weather centre and the Site, based on the widely-accepted Deaves and Harris log law wind model of the atmospheric boundary layer and BS EN 1991-1-4:2005.

The resulting climate data is summarised in Figure A12.3 in terms of the seasonal wind speed and direction probability distributions at a reference height of 118 m, corresponding to the approximate maximum roof height of the Proposed Scheme above the local ground level.

The factors applied to correct the statistics from 10 m height in open-country terrain at sea-level to reference height at the Site are also presented.

Wind Environment Results

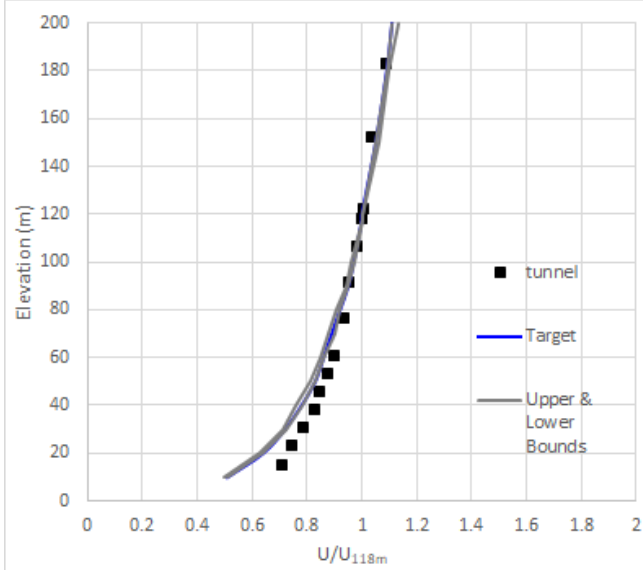
The measured wind speed ratios from the wind tunnel tests were combined with the wind statistics applicable to the Site to assess the pedestrian level wind environment based on the industry standard Lawson criteria for pedestrian comfort and safety. The resulting annual and seasonal ratings for each measurement location are summarised in Figures A12.4 for the following scenarios:

- Configuration 1: Existing Site (baseline) with existing surrounding buildings and vegetation;
- Configuration 2: Proposed Scheme (including landscaping proposals) with existing surrounding buildings and vegetation; and
- Configuration 3: Proposed Scheme (including landscaping proposals) with existing and future (cumulative) surrounding buildings and existing vegetation.

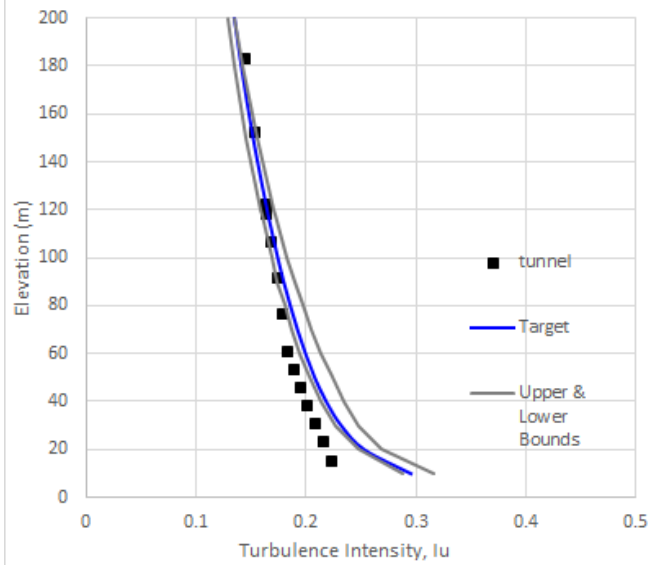
With regards to the seasons, winter is typically the worst-case for activities undertaken throughout the year but is not considered significant for recreational uses. Summer is considered the key season for recreational activities.

Figure A12.1: Wind Tunnel Boundary Layer Simulation

Mean Wind Speed



Longitudinal Turbulence Intensity



1-Second Gust Wind Speed

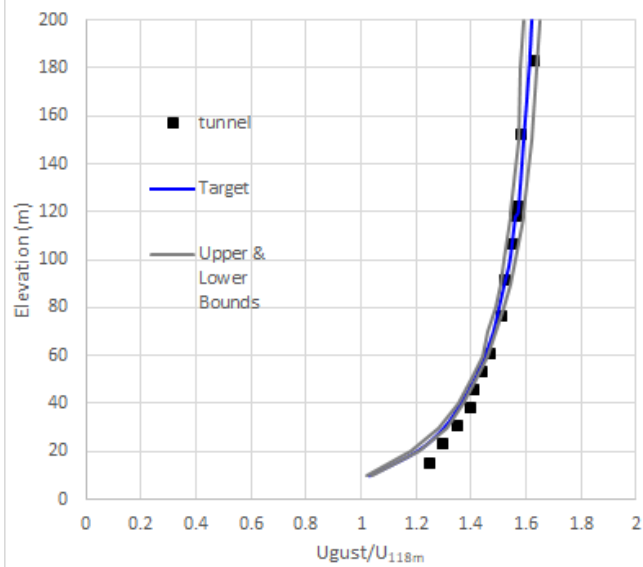


Figure A12.2a: Wind Tunnel Model

Existing Site



Close of Proposed Scheme



Close of Proposed Scheme



Proposed Scheme with Existing Surrounds



Proposed Scheme with Future Surrounds



Wind Tunnel Set-up



Figure A12.2b: Wind Tunnel Model - Landscaping

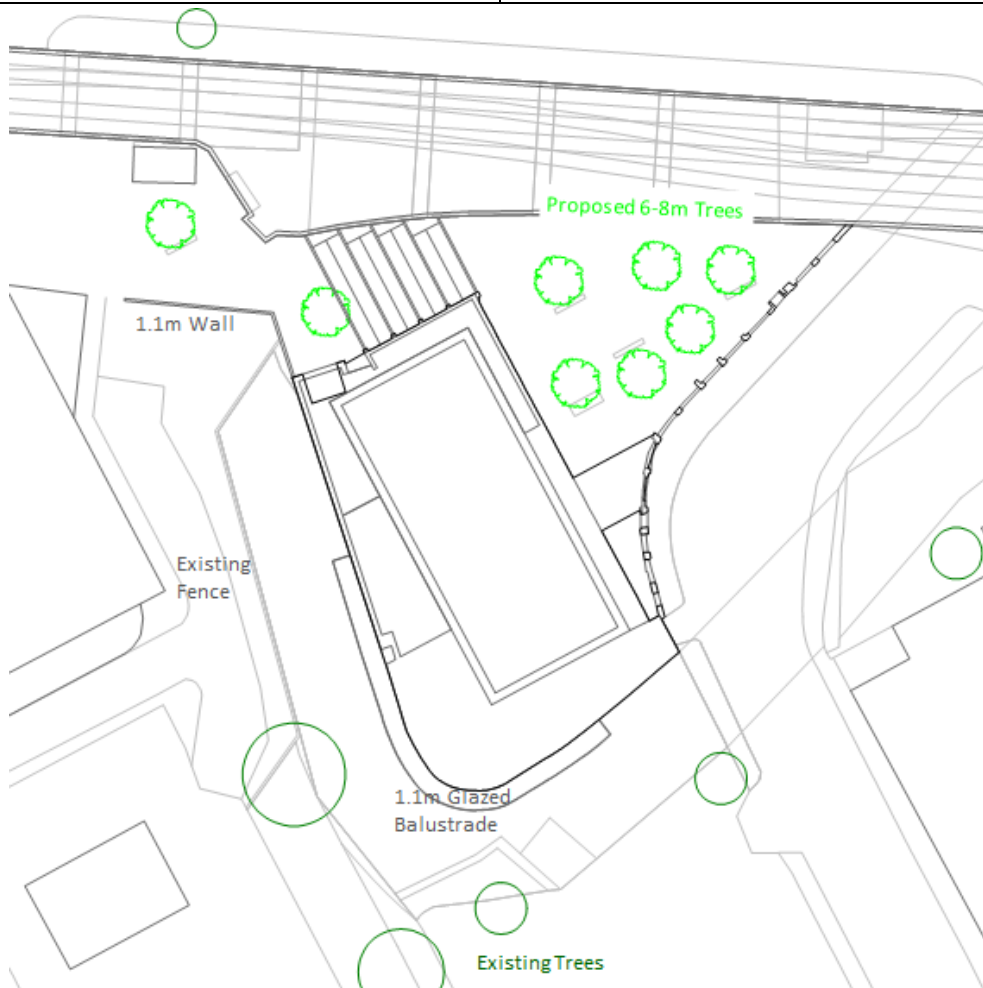
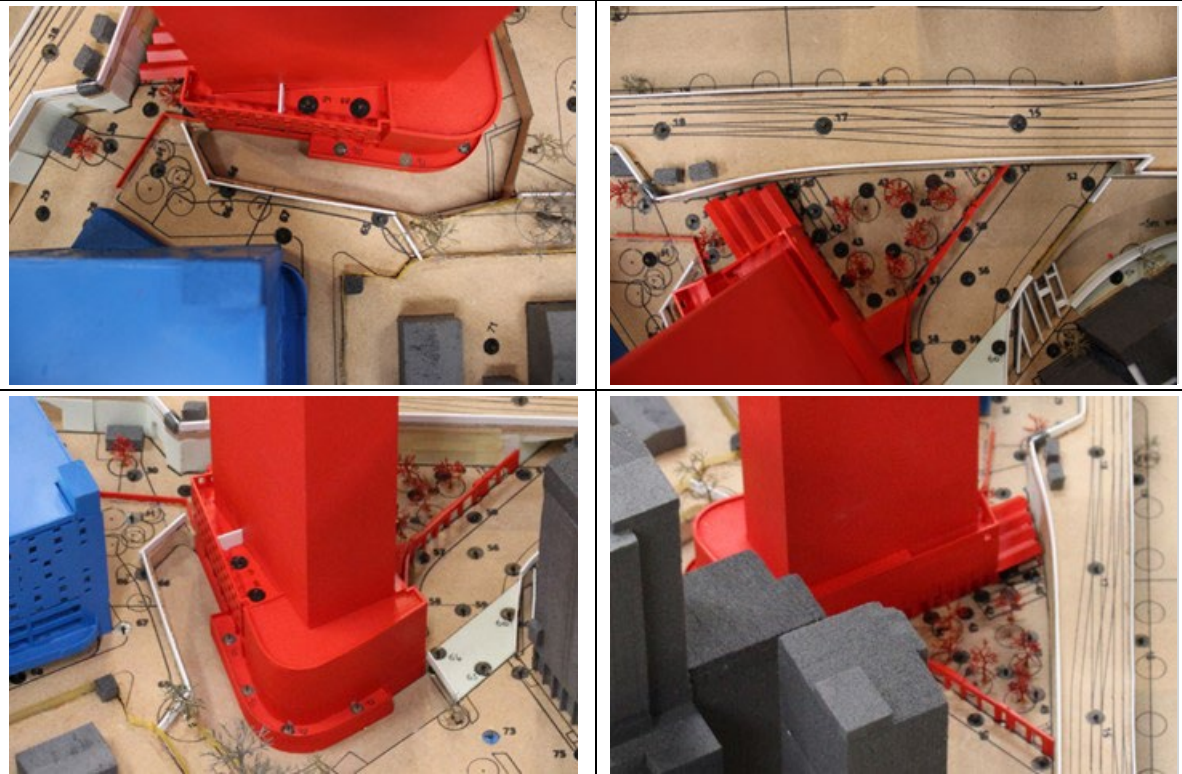
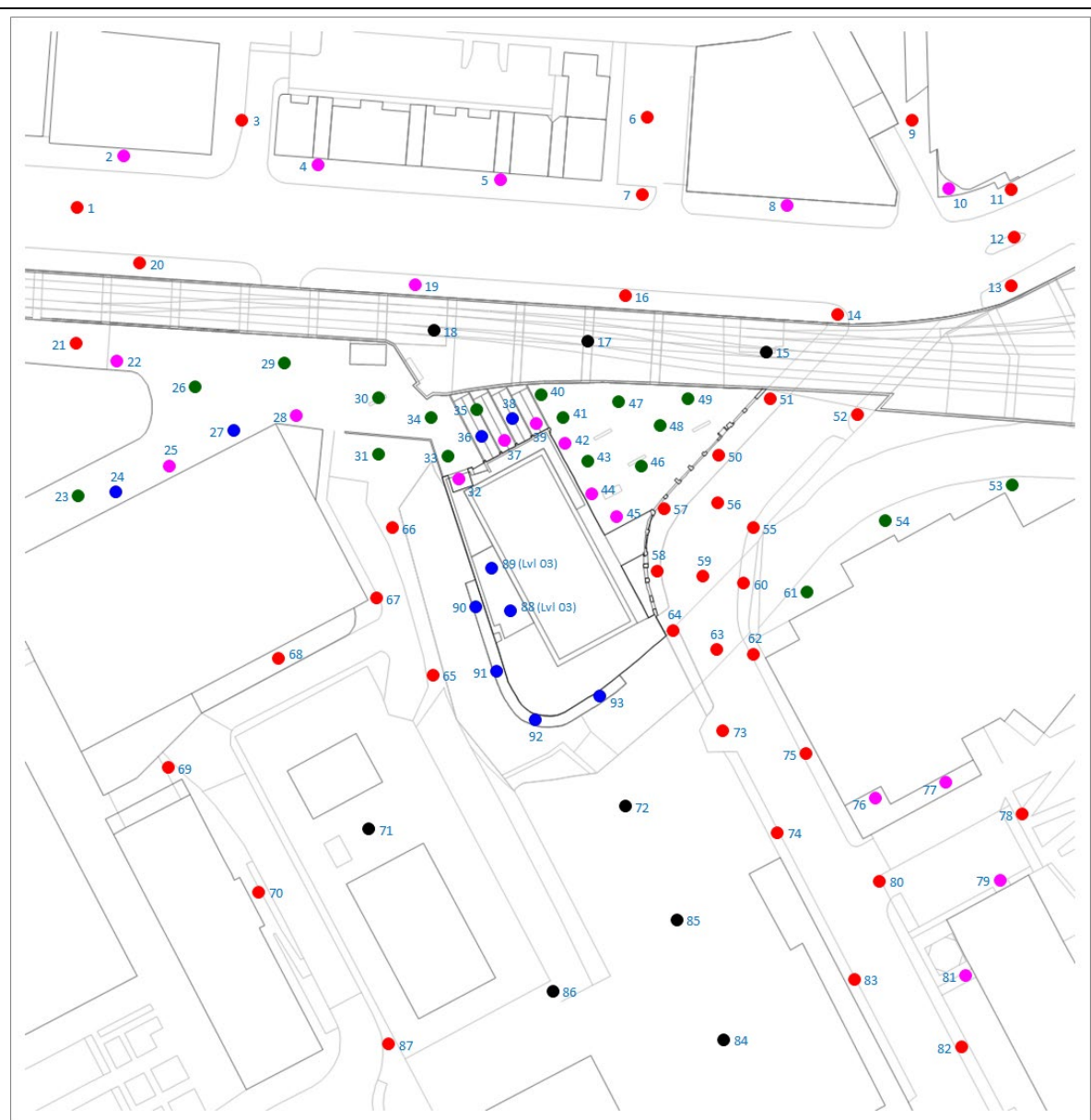


Figure A12.2c: Wind Speed Sensor Locations and Proposed / Existing Uses



Outdoor Seating (e.g. café spill-out, picnics, etc)

Entrance, Waiting (e.g. meeting point, bus stop, etc), Active Frontage

General Leisure (e.g. playspace)

Thoroughfare

Car-park, Worksite, Other non-sensitive uses

Figure A12.3a: Wind Speed Correction Factors, Open Country at Sea-Level to Ref. Height (118 m) at Site

Direction	0°	22.5°	45°	67.5°	90°	112.5°	135°	157.5°
Factor	1.37	1.36	1.35	1.34	1.35	1.36	1.36	1.36
Direction	180°	202.5°	225°	247.5°	270°	292.5°	315°	337.5°
Factor	1.36	1.35	1.36	1.37	1.37	1.36	1.37	1.37

Figure A12.3b: Wind Climate at Site (at Ref. Height of 118 m)

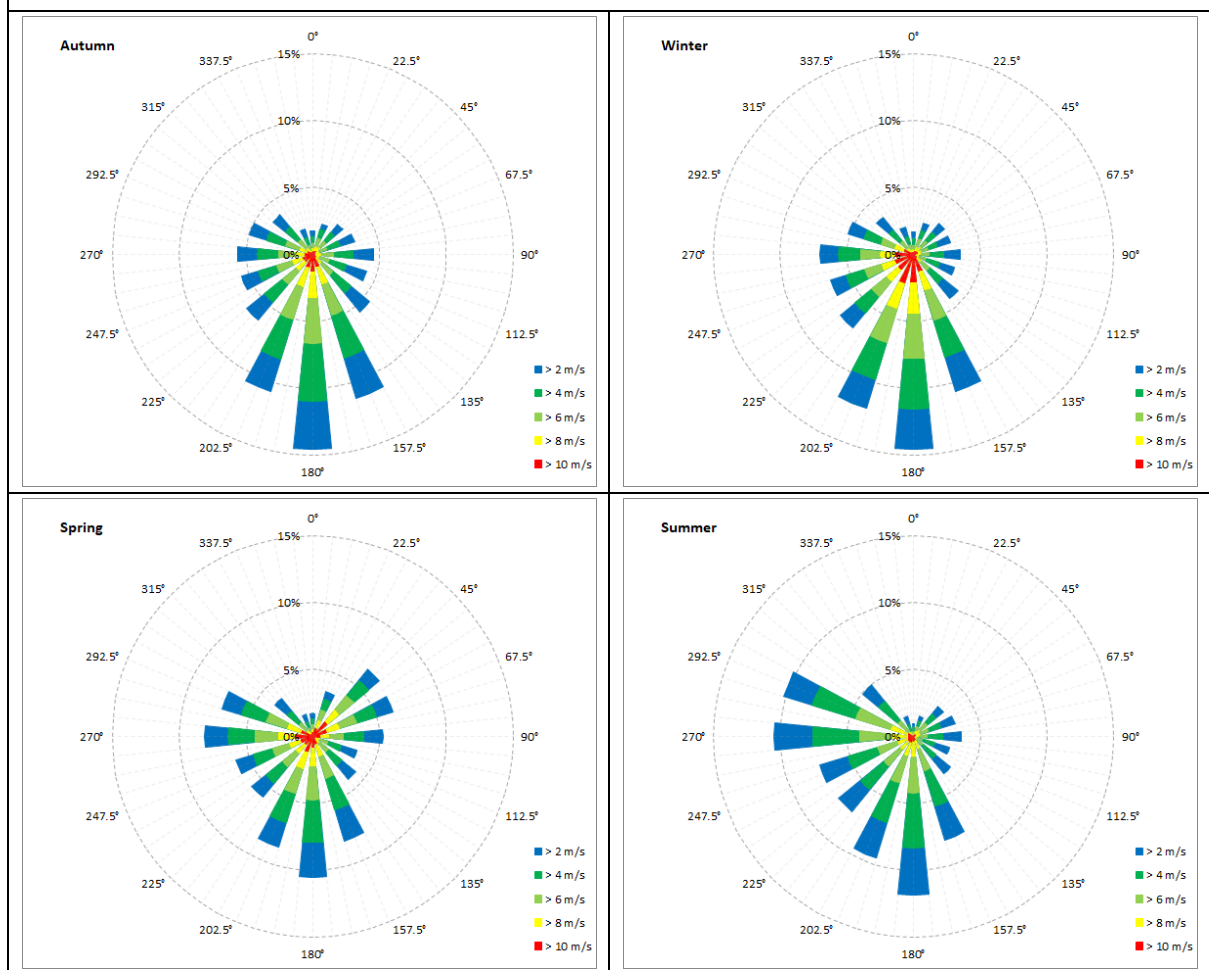


Figure A12.4a: Pedestrian Level Wind Environment – Annual Comfort and Safety Ratings

Existing Site Conditions



Proposed Scheme with Existing Surrounds

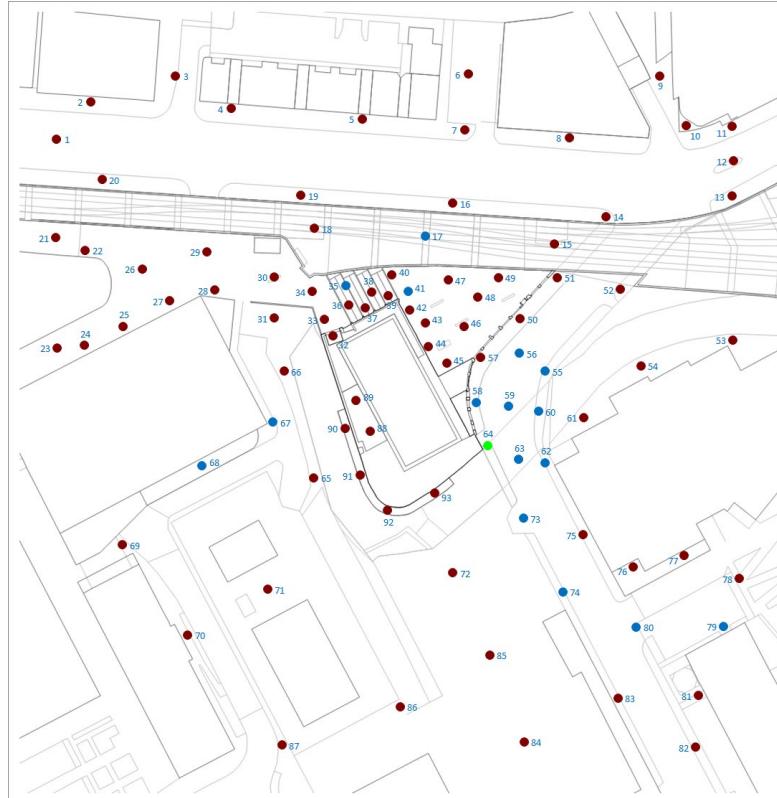


Figure A12.4a: Pedestrian Level Wind Environment – Annual Comfort and Safety Ratings

Proposed Scheme
with Future
Surrounds

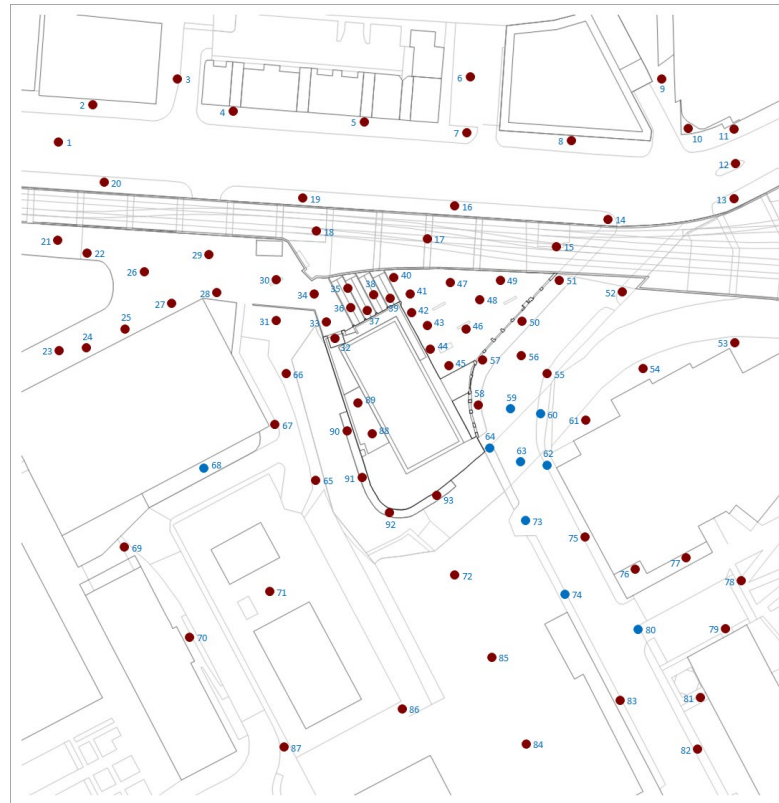


Figure A12.4b: Pedestrian Level Wind Environment – Autumn Comfort and Safety Ratings

Existing Site Conditions



Proposed Scheme with Existing Surrounds

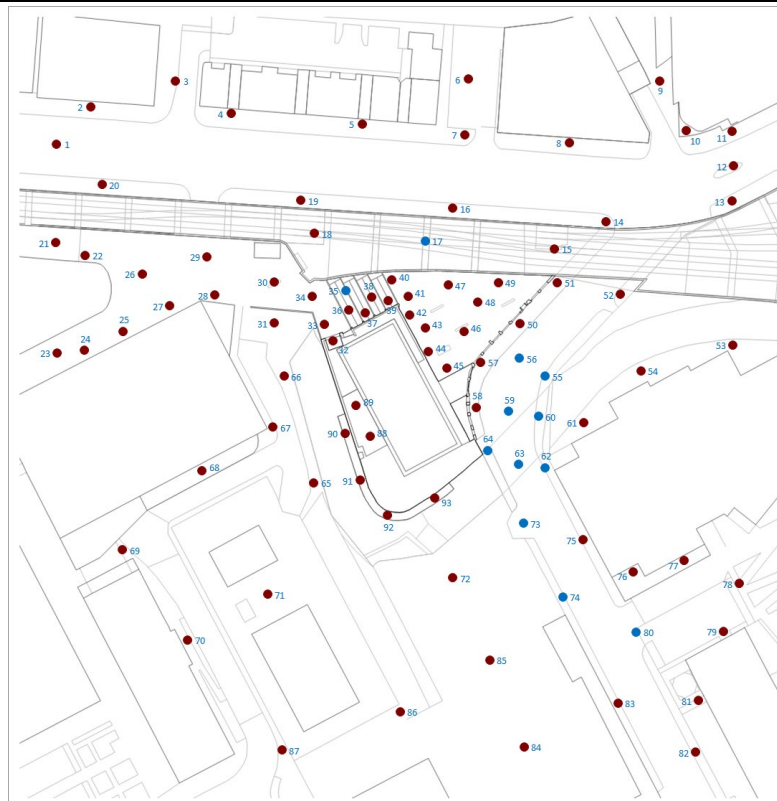
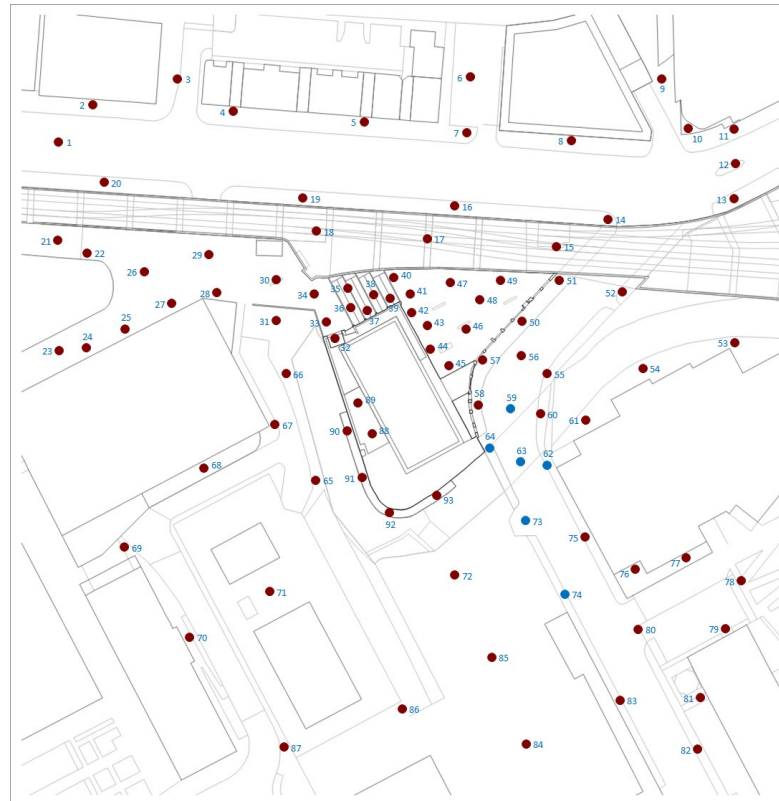


Figure A12.4b: Pedestrian Level Wind Environment – Autumn Comfort and Safety Ratings

Proposed Scheme
with Future
Surrounds



Urban
microclimate

Figure A12.4c: Pedestrian Level Wind Environment – Winter Comfort and Safety Ratings

Existing Site Conditions



Proposed Scheme with Existing Surrounds

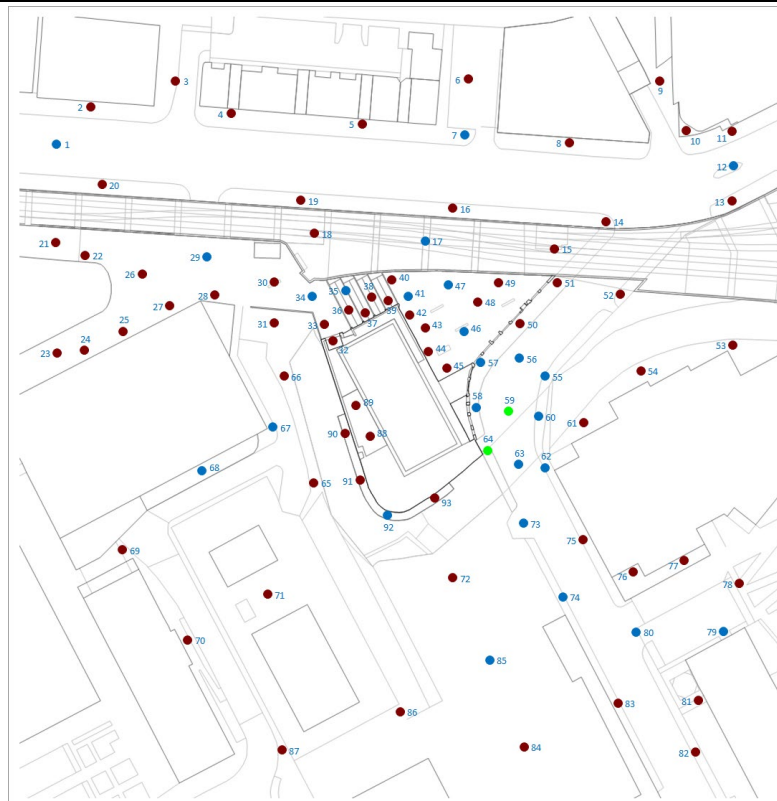


Figure A12.4c: Pedestrian Level Wind Environment – Winter Comfort and Safety Ratings

Proposed Scheme
with Future
Surrounds

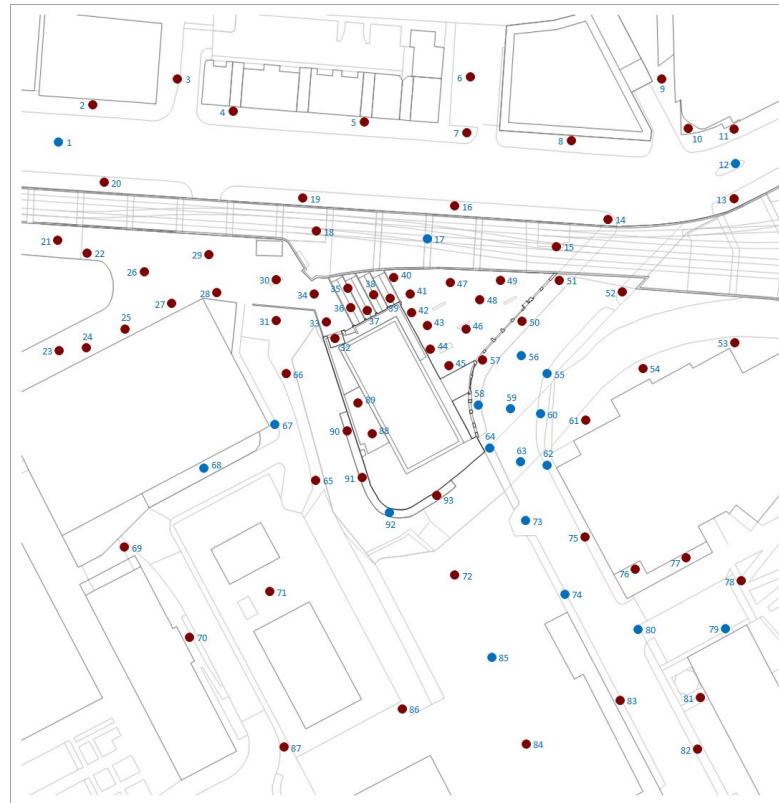


Figure A12.4d: Pedestrian Level Wind Environment – Spring Comfort and Safety Ratings

Existing Site Conditions



Proposed Scheme with Existing Surrounds

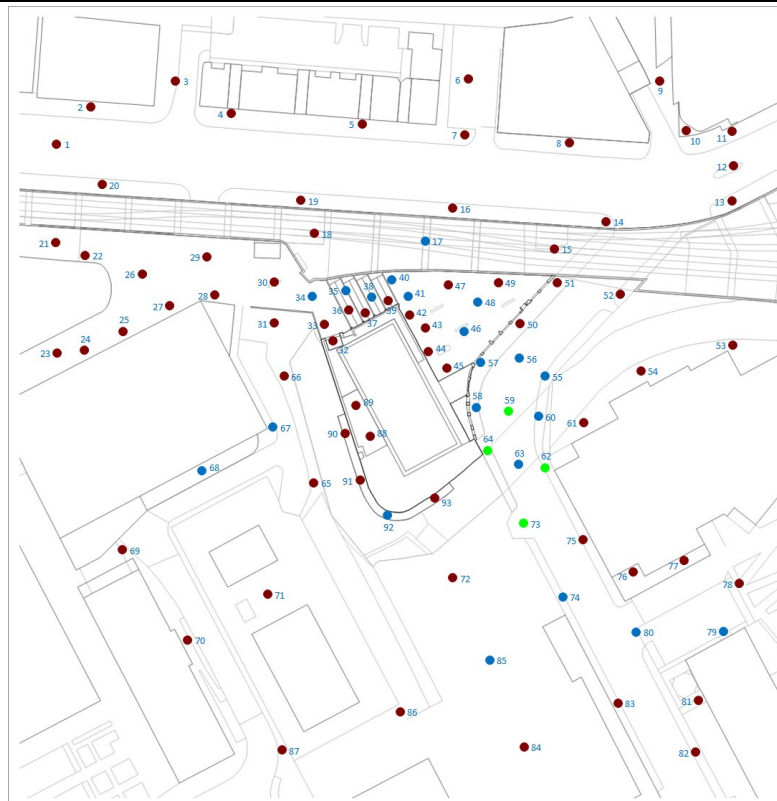


Figure A12.4d: Pedestrian Level Wind Environment – Spring Comfort and Safety Ratings

Proposed Scheme
with Future
Surrounds

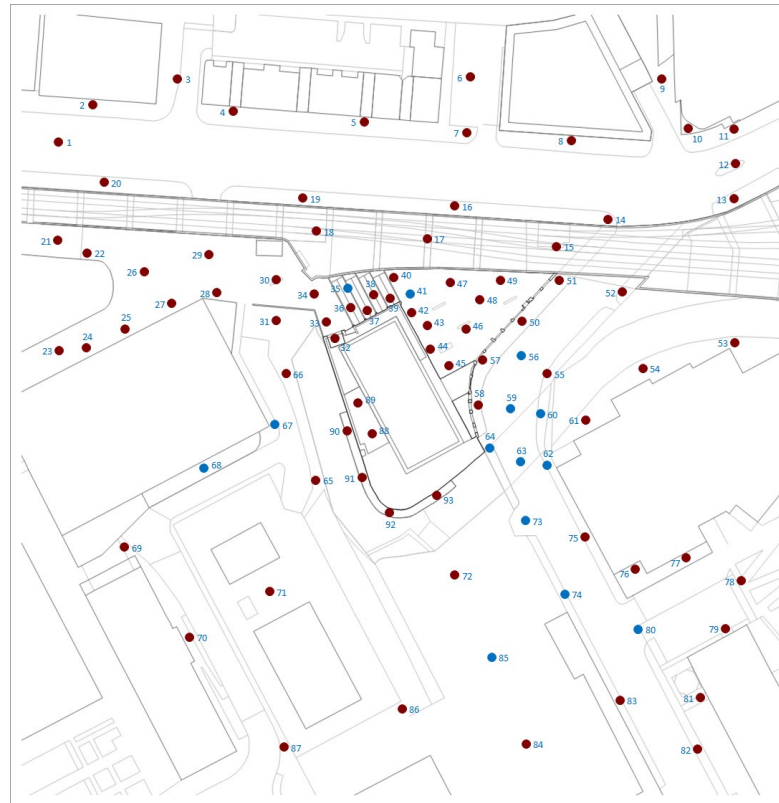


Figure A12.4e: Pedestrian Level Wind Environment – Summer Comfort and Safety Ratings

Existing Site Conditions



Proposed Scheme with Existing Surrounds

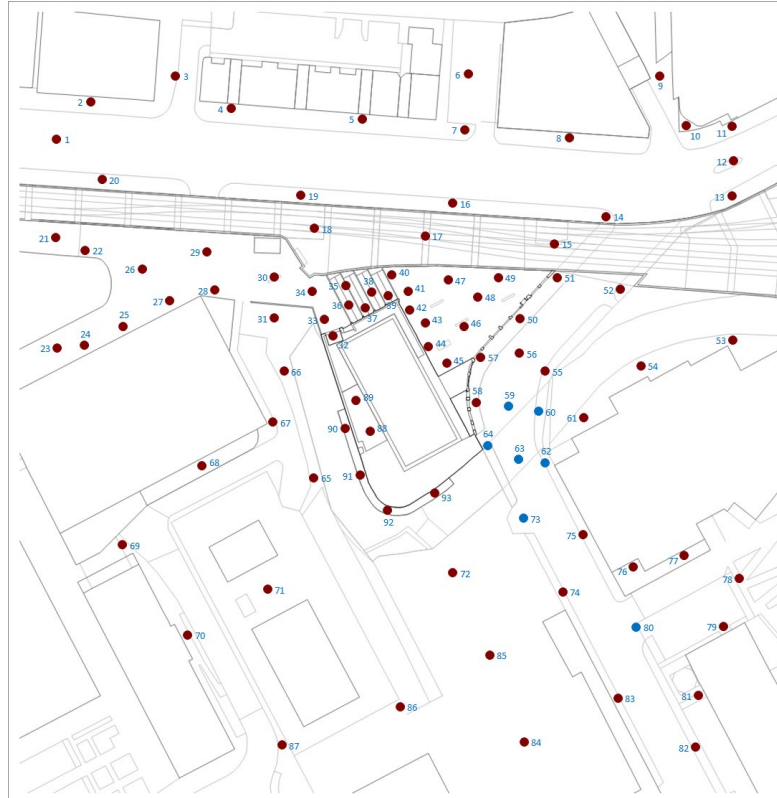


Figure A12.4e: Pedestrian Level Wind Environment – Summer Comfort and Safety Ratings

Proposed Scheme
with Future
Surrounds

