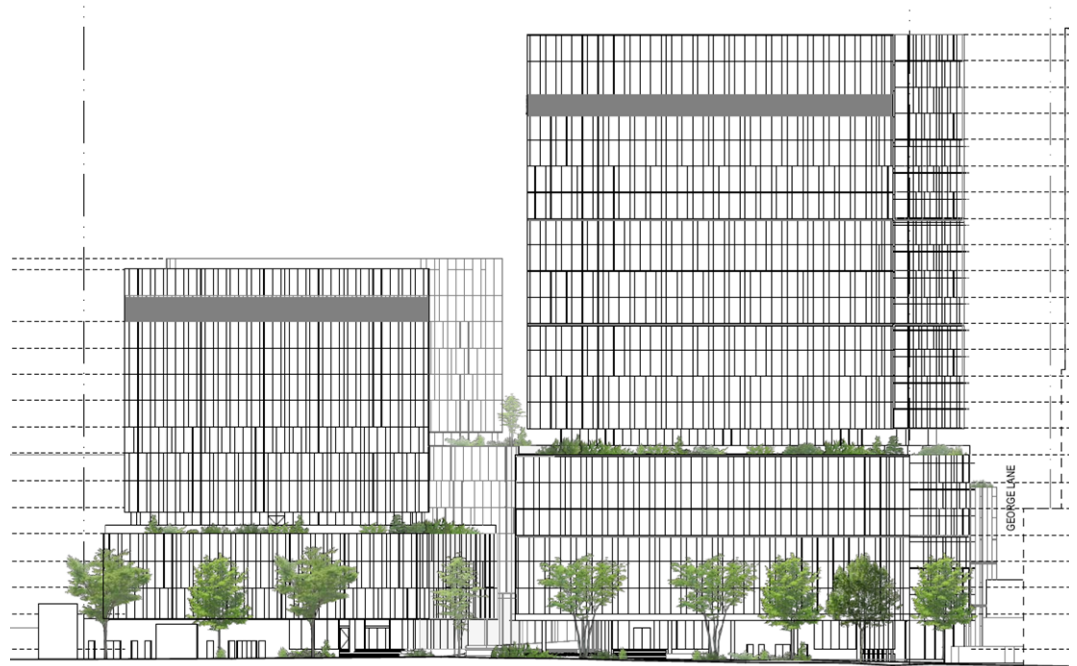




PEDESTRIAN WIND ENVIRONMENT STATEMENT

CIVIC PLACE, LIVERPOOL

WE999-01F02(REV4)- WS REPORT

MAY 5, 2020

Prepared for:

Built

Level 7, 343 George St

Sydney, NSW 2000

DOCUMENT CONTROL

Date	Revision History	Issued Revision	Prepared By (initials)	Instructed By (initials)	Reviewed & Authorised by (initials)
August 12, 2019	Initial.	0	MV	SR	TR
September 10, 2019	Updated based on received comments.	1	MV	SR	TR
April 23, 2020	Updated BLCP Master Plan design	2	JG	SR	HK
May 5, 2020	Updated Treatment Comments	3	JG	SR	HK
May 5, 2020	Updated Treatment Comments and Figures	4	JG	SR	HK

The work presented in this document was carried out in accordance with the Windtech Consultants Quality Assurance System, which is based on International Standard ISO 9001.

This document is issued subject to review and authorisation by the Team Leader noted by the initials printed in the last column above. If no initials appear, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

This document is prepared for our Client's particular requirements which are based on a specific brief with limitations as agreed to with the Client. It is not intended for and should not be relied upon by a third party and no responsibility is undertaken to any third party without prior consent provided by Windtech Consultants. The information herein should not be reproduced, presented or reviewed except in full. Prior to passing on to a third party, the Client is to fully inform the third party of the specific brief and limitations associated with the commission.

EXECUTIVE SUMMARY

This report presents an opinion on the likely impact of the building massing of Civic Place, Liverpool, on the local wind environment at the critical outdoor areas within and around the subject development. The effect of wind activity is examined for the three predominant wind directions for the southwestern Sydney region; namely the north-easterly, south-easterly and westerly winds. The analysis of the wind effects relating to the proposed development was carried out in the context of the local wind climate, building morphology and land topography.

The conclusions of this report are drawn from our extensive experience in this field and are based on an examination of the BLCP Master Plan drawings. No wind tunnel testing was undertaken for the subject development, and hence this report addresses only the general wind effects and any localised effects that are identifiable by visual inspection. Any recommendations in this report are made only in-principle and are based on our extensive experience in the study of wind environment effects.

The results of the assessment of the envelope scheme of the subject development is relatively exposed to the three prevailing wind directions, affecting the site. As a result, there is a potential impact on the wind comfort conditions within certain areas of the Civic Plaza, Upper Civic Plaza, Pedestrian Laneways, Terminus Street pedestrian footpaths, and some areas of the elevated building terraces. The following treatments are recommended for areas where wind effects are expected to be prevalent:

Ground Level:

- Recommendation to include Upper Ground Floor awnings along the south-eastern facades (Terminus Street aspect) of the Council and Commercial buildings.
- Recommendation to include densely foliating evergreen trees and strategically positioned densely foliating evergreen shrubs/hedges along the Terminus Street entry areas to the Upper Civic Plaza.
- Recommendation to include strategically located densely foliating evergreen trees along the Scott Street pedestrian footpath areas and within the Civic Plaza.
- Recommendation to include strategic tree planting and vegetation within the landscape zones adjacent Augusta Cullen Plaza and along the pedestrian passageway between the Library and Council buildings.
- Recommendation to include strategically located densely foliating evergreen planting/trees along the pedestrian link should it be designed such that it is open on both aspects and/or to external elements.

Council Building Terraces:

- The inclusion of impermeable screens along the south-eastern perimeter of the Level 01 and 07 terraces.
- Recommendation to increase the planter area at the southern most corner of the Level 04 terrace. Recommendation to include densely foliating evergreen shrubs/hedges within the Level 04 terrace planter boxes.
- The inclusion of impermeable screens along the eastern and western perimeter of the Level 06 terrace.

Commercial Building Terrace:

- The inclusion of impermeable screens along the western perimeter of the terrace.
- Recommendation to include strategically located densely foliating evergreen hedges along the northern and southern aspect of the terrace.

It is recommended that the wind conditions within and around the site be verified through wind tunnel testing. Wind tunnel testing will be able to provide a quantitative analysis of the wind conditions and validate the requirement for wind mitigation measures, including the size and extent of treatments to ensure suitable conditions are provided for the trafficable outdoor areas throughout the development.

CONTENTS

1	Introduction	1
2	Description of the Development and Surroundings	3
3	Regional Wind climate	6
4	Wind Effects on People	7
5	Results and Discussion	8
5.1	Lower and Upper Ground Floors	8
5.2	Elevated Terraces	10
5.2.1	Council Building	10
5.2.2	Commercial Building	11
5.3	General Recommendations	11
6	References	19

1 INTRODUCTION

This Pedestrian Wind Environment Statement is submitted to Liverpool City Council (Council) in support of a Concept Development Application (Concept Proposal) for a new mixed-use precinct known as Liverpool Civic Place at 52 Scott Street, Liverpool (the site). This application sets out a Concept Proposal for the development of the site under Section 4.23 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Pedestrian Wind Environment Statement has been revised for Liverpool City Council (Council) and Architectus as the relevant assessment authority on behalf of Built Development Group (Built). It is in response to Architectus' correspondence dated 31 January 2019 (RFI) which raised various matters for consideration as part of the assessment of DA/585/2019, being a Concept Proposal for a new mixed use precinct known as Liverpool Civic Place at 52 Scott Street, Liverpool.

This Concept Proposal seeks approval for a mixed-use concept. Specifically, the following key components and development parameters:

- A building envelope accommodating 4 storeys and for the purpose of an information and education facility (public library) use.
- A building envelope accommodating 14 storeys and for the purpose of a public administration building use, and either (or a combination of) commercial premises or child-care centre uses.
- A building envelope accommodating 24 storeys and which will accommodate either (or a combination of) commercial premises, retail premises, educational establishments, tourist and visitor accommodation or boarding house (student accommodation) uses.
- A landscaping and public domain concept including the provision of a public through-site link connecting Scott Street to the north through to Terminus Street to the south; and
- Concept building envelope for a three-level shared basement car park across the entire site to accommodate parking for all future uses, and a public car park.

No physical works are proposed as part of this Concept Proposal. The subject application will seek approval for maximum building envelopes, land uses and GFA. It is emphasised that the proposed building envelopes set the maximum vertical and horizontal parameters of building lines and the proposed GFA will be accommodated within the building envelopes. The building envelopes are deliberately designed with sufficient volume to allow for design excellence to be achieved through the detailed building design and articulation.

A reference design has also been submitted which illustrates one of the ways a detailed design could be facilitated within the proposed building envelopes. However, approval is not sought for the reference design. The final design will be resolved in the subsequent 'detailed proposal'

DAs. Following this, each individual tenant will seek development consent for the fit-out and use of their respective tenancy.

An opinion on the likely impact of the proposed design on the local wind environment affecting pedestrians within the critical outdoor areas within and around the subject development is presented in this report. The analysis of wind effects relating to the proposed development was carried out in the context of the predominant wind directions for the region, building morphology of the development and nearby buildings, and local land topography. The conclusions of this report are drawn from our extensive experience in the field of wind engineering and studies of wind environment effects.

No wind tunnel testing was undertaken for this assessment. Hence, this report addresses only the general wind effects and any localised effects that are identifiable by visual inspection. Any recommendations in this report are made only in-principle.

2 DESCRIPTION OF THE DEVELOPMENT AND SURROUNDINGS

The site is located at 52 Scott Street, Liverpool, within the Liverpool City Council Local Government Area (LGA) as illustrated in Figure 1. The site is located at the southern fringe of the Liverpool CBD. The site is approximately 300m south west of Liverpool Railway Station and is also in the vicinity of a number of regionally significant land uses and features including Liverpool Hospital, Westfield Liverpool, Western Sydney University Liverpool Campus, the Georges River and Bigge Park public open space as illustrated in Figure 1.

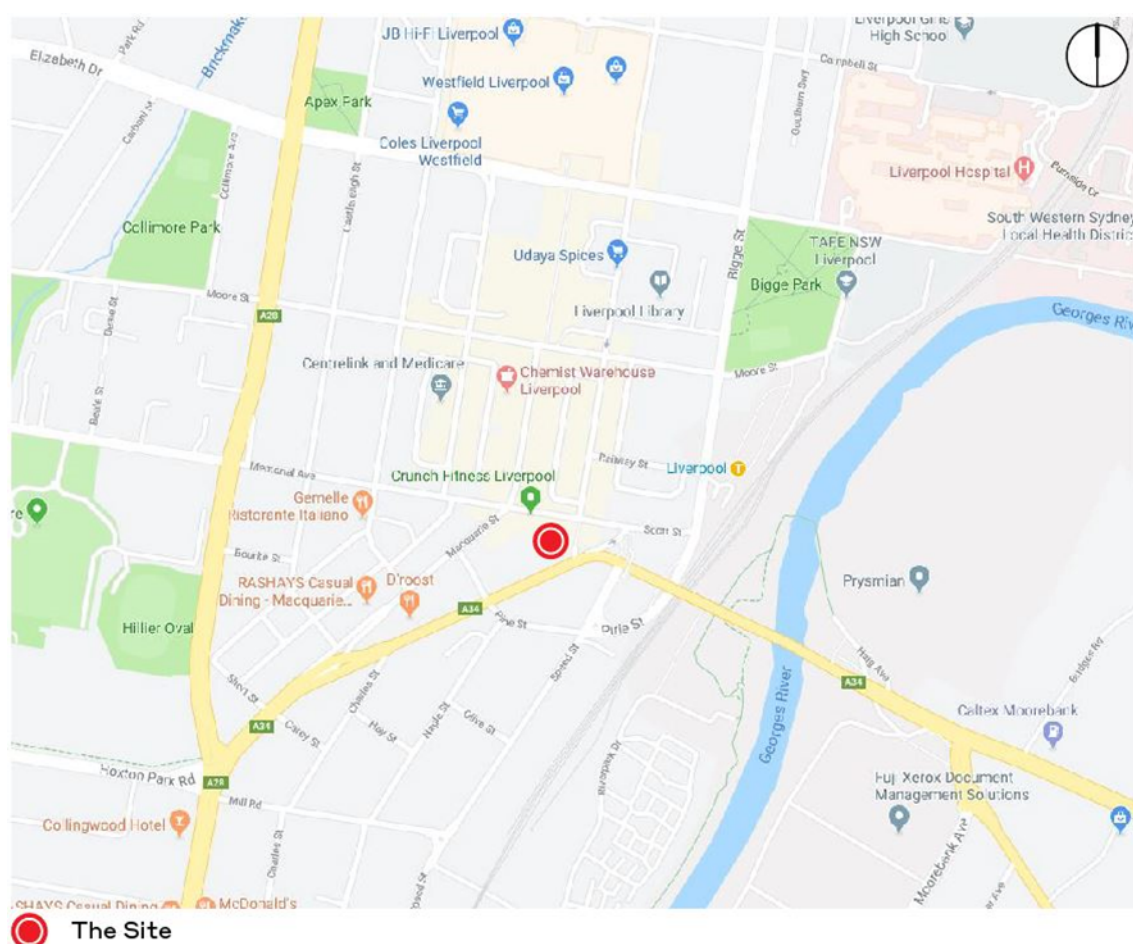


Figure 1: Site Location

This site is irregular in shape and comprises 12 lots legally described below and identified in Figure 2 below.

- Lot 1 in DP 514817;
- Lot 2 in DP 229979;
- Lot 17 in DP 81842;
- Lot 3 in DP 229979;
- Lot 11 in DP 522284;
- Lot 201 in DP1224084;
- Lot 100 in DP 877435;
- Lot 12 in DP 657056;
- Lot 1 in DP 507070;
- Lot 22 in DP 441010;
- Lot 23 in DP 441010; and
- Lot 1 in DP 229979.



Figure 2: Site Lot Boundaries

The site has a total area of 9189.5m² and has three road frontages, including a primary frontage to Scott Street (98m frontage) to the north, George Lane (40m frontage) to the east and Terminus Street (115m frontage) to the south. The site currently consists of a two-storey commercial building and a two-storey retail building along the eastern boundary. The two existing buildings are divided by a vacant lot. An aerial photograph of the site is shown at Figure 3 below.



Figure 3: Site Aerial

A 9-storey mixed-use building is located on the same block, immediately to the west of the site. An existing plaza area is also located to the west, between the site and the stand-alone, 2-storey Memorial School of Arts building. Pedestrian thoroughfare at ground level exists between these two buildings. Surrounding the block bounded by Macquarie, Scott and Terminus Streets are predominantly low-rise retail buildings, with medium-rise buildings to the north-east at the corner of George Street and Scott Street. A survey of the land topography indicates that the land slopes down towards the north-west of the site. This assessment covers the various outdoor trafficable areas within and around the proposed development.

3 REGIONAL WIND CLIMATE

The south-western region of Sydney is governed by three principal wind directions which can potentially affect the subject development. These winds prevail from the north-east, south-east and west. These critical wind directions were determined by Windtech Consultants from directional wind speeds observed at the meteorological station located at Bankstown Airport and operated by the Bureau of Meteorology. Surface wind conditions were sampled at half-hourly intervals from 1993 to 2016, and then corrected by Windtech Consultants to represent incident wind speeds associated with flat, open terrain at a height of 10 m above ground level. The polar plot of Figure 4 shows the annual and 5% exceedance mean wind speeds for the region per wind sector. The frequency of occurrence for each wind sector was also determined and is shown in Figure 4.

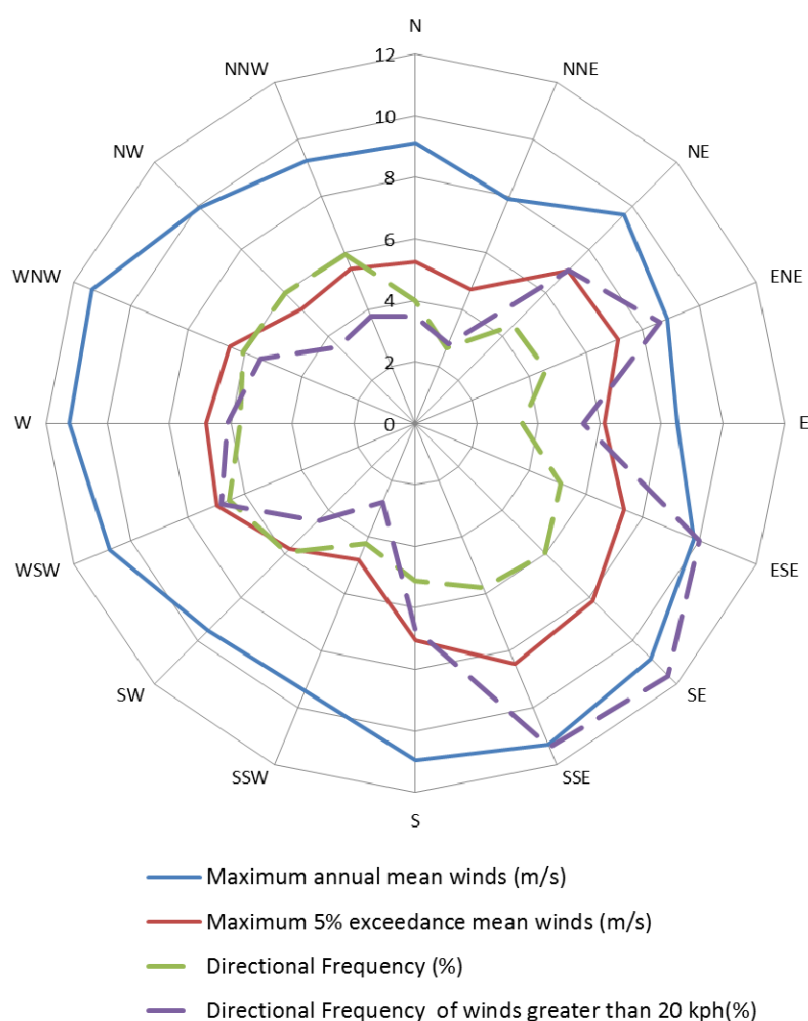


Figure 4: Annual and 5% Exceedance Hourly Mean Wind Speeds, and Frequencies of Occurrence, for the south-western region of Sydney (referenced to 10m above ground in standard open terrain)

4 WIND EFFECTS ON PEOPLE

The acceptability of wind speeds in any area is dependent upon its use. For example, people walking or window-shopping will tolerate higher wind speeds than those seated at outdoor restaurants. Various researchers, such as A.G. Davenport, T.V. Lawson, W.H. Melbourne, and A.D. Penwarden, have published wind speed criteria on pedestrian comfort in outdoor spaces for a variety of activities. Some Councils and Local Government Authorities adopt elements of these recommendations into their planning control requirements.

For example, A.D. Penwarden (1973) developed a modified version of the Beaufort scale which describes the effects of various wind intensities on people, as presented in Table 1. The effects relate to mean wind speeds which occur at a high frequency (a probability of occurrence exceeding 5%). Higher ranges of wind speeds can be tolerated by pedestrians for rarer events.

Table 1: Summary of Wind Effects on People (A.D. Penwarden, 1973)

Type of Winds	Beaufort Number	Mean Wind Speed (m/s)	Effects
Calm	0	Less than 0.3	Negligible.
Calm, light air	1	0.3 – 1.6	No noticeable wind.
Light breeze	2	1.6 – 3.4	Wind felt on face.
Gentle breeze	3	3.4 – 5.5	Hair is disturbed, clothing flaps, newspapers difficult to read.
Moderate breeze	4	5.5 – 8.0	Raises dust, dry soil and loose paper, hair disarranged.
Fresh breeze	5	8.0 – 10.8	Force of wind felt on body, danger of stumbling.
Strong breeze	6	10.8 – 13.9	Umbrellas used with difficulty, hair blown straight, difficult to walk steadily, unpleasant wind noise.
Near gale	7	13.9 – 17.2	Inconvenience felt when walking.
Gale	8	17.2 – 20.8	Progress impeded, difficulty balancing in gusts.
Strong gale	9	Greater than 20.8	People blown over.

It is important to highlight that local, site-specific wind speeds can only be accurately quantified with a wind tunnel study. The outcomes of this report address only general wind effects and any localised effects that were identified by visual inspection of architectural drawings and local building massing. The acceptability of the conditions for outdoor areas were determined based on their intended use. Recommendations in this report are only in-principle and are based on our extensive experience in the study of wind environment effects.

5 RESULTS AND DISCUSSION

The expected wind conditions are discussed in the following sub-sections of this report for the various outdoor areas within and around the subject development. The interaction between the wind and building morphology is considered, including the distances between the surrounding buildings and the proposed development. Only the potentially critical wind effects are discussed in this report.

The Upper and Lower Civic Plaza areas are intended to be primarily used for pedestrian circulation and building egress. Similarly, the pedestrian footpath areas along Scott Street, Macquarie Street, George Lane and Terminus Street are intended to be primarily used for pedestrian circulation. Augusta Cullen Plaza which is located between the library and the School of Arts building, may be utilised for standing or short-duration activities. Similar activities are expected at the terraces on Level 07 of the Commercial building and Levels 01, 02, 04 and 07 of the Council building.

The recommended mean wind speed criterion for wind conditions at circulation areas is 7.5 m/s for a 5% probability of exceedance, whereas the Augusta Cullen Plaza will need to satisfy a more stringent comfort criterion of 5.5 m/s for a 5% probability of exceedance. In addition to the abovementioned comfort criteria, all outdoor trafficable areas are required to meet the safety limit, represented by an annual maximum 3-second gust wind speed of 23 m/s. Although this assessment is of a qualitative nature, the abovementioned criteria are considered when assessing the wind environment impacts.

Due to the complexities of the site, which includes 4 buildings with a maximum height of approximately 90 m above ground level, it is recommended that the wind conditions within and around the site be verified through wind tunnel testing during the Stage 2 Detailed Design phase.

5.1 Lower and Upper Ground Floors

The neighbouring retail and commercial buildings will assist in providing moderate shielding from directly impacting the ground level pedestrian footpath areas due to the prevailing winds. The north-east to south-west orientation of Macquarie Street aligns with the prevailing north-easterly winds and as such these winds are expected to freely travel along the corresponding pedestrian footpath, similar to existing conditions. Similarly, the east to west orientation of Scott Street aligns well with the prevailing westerly winds, which are expected to side stream along the footpath areas immediately adjacent to the Hotel.

The northern access areas to the Civic Plaza are expected to experience potential wind impacts from the prevailing north-easterly and westerly winds. It is recommended to include strategically located densely foliating evergreen trees along the Scott Street pedestrian footpath areas and within the Civic Plaza.

The pedestrian passage between the Library and the Council building has the potential to be impacted by the prevailing westerly winds funnelling between this space. It is recommended to increase the planter zone areas south of the library and to include strategic tree planting and vegetation within the landscape zones adjacent Augusta Cullen Plaza and adjacent to the passageway between the two buildings.

The masterplan envelope indicates the potential for a pedestrian link between George Lane and the Civic Plaza. Should the pedestrian link be designed such that it is open on both aspects and/or exposed to external elements, then the proposed orientation is expected to capture the prevailing north-easterly and westerly winds. It is recommended to include strategically located densely foliating evergreen planting/trees within this area to assist with the potential of funnelling wind conditions. George Lane receives moderate shielding from the prevailing north-easterly and westerly winds from the neighbouring sites and the proposed Commercial building, however there is the potential for the prevailing south to south-easterly winds to interact with the Commercial building and funnel along George Lane. The wind conditions along George Lane are recommended to be investigated through wind tunnel testing for the proposed scheme and treatment solutions to be investigated at a later stage. The retention of densely foliating evergreen trees along Terminus Street will assist with low level side streaming winds at the southern end of George Lane.

Similarly, there is also the potential for the prevailing westerly winds to funnel between the pedestrian area between the Library and the Council building. It is recommended to include strategically located densely foliating evergreen trees along the pedestrian laneway to assist in filtering the funnelling winds.

The prevailing south-easterly winds are expected to be captured by the south-eastern facades of the Council and Commercial buildings, with the ability to downwash towards the pedestrian footpath areas along Terminus Street. The downwash winds that reach the footpath areas have the ability to sidestream along Terminus Street and potentially corner accelerate into the Upper Civic Plaza and George Lane. The recessed nature of the Council and Commercial building form as well as the Commercial building Level 01 overhang at the south-west aspect may cause further acceleration of the downwash winds. It is recommended to include Upper Ground Floor awnings along the south-eastern facades of the Council and Commercial buildings.

Similarly, due to the pedestrian entry location to the Upper Civic Plaza and the adjacent Council and Commercial building, the Upper Civic Plaza is expected to experience funnelling wind effects due to the prevailing south-easterly winds. It is recommended to include densely foliating evergreen trees and strategically positioned densely foliating evergreen shrubs/hedges.

5.2 Elevated Terraces

The elevated terraces on the Council and Commercial buildings have been identified as potential areas for communal and/or recreational activities amongst patrons. These areas are intended to be used by patrons for short duration activities.

The site does not receive sufficient shielding of winds from neighbouring buildings at elevated heights. As such the elevated areas on Level 01, 02, 04 and 07 are exposed to the following potential wind effects, including direct wind, corner acceleration and side streaming effects.

5.2.1 Council Building

The Level 01 and 07 terrace have the potential to be exposed to westerly winds corner accelerating at the southernmost end of the terrace. To assist with mitigating the westerly winds from corner accelerating it is recommended to investigate the implementation of impermeable screening (the height of which can be investigated with detailed wind tunnel testing) along the south-eastern perimeter of the Level 01 and Level 07 terrace.

The Level 06 terrace has the potential to be exposed to the corner accelerating winds at both ends of the terrace due to exposure to the prevailing north-easterly and westerly winds. It is recommended to investigate the implementation of impermeable screening (the height of which can be investigated with detailed wind tunnel testing) along the eastern and western perimeter of the terrace to assist with corner acceleration. The relatively close proximity of the neighbouring 300 Macquarie Street development may assist in stagnating the corner acceleration at the western end of the terrace.

The Level 04 terrace is noted to be exposed along the eastern, southern and western aspects. The limited shielding and exposure to the prevailing south-easterly and westerly winds proposes potential issues at the southern and eastern most corners of the terrace. It is recommended to increase the planter box area at the southernmost corner, thus increasing the planting area to include densely foliating evergreen shrubs/hedges and more importantly, reducing the useable area at the corner, encouraging patrons to use the corner as a passageway rather than for short duration activities. Similarly, it is recommended to include densely foliating evergreen shrubs/hedges within the planter boxes adjacent to the eastern most corner of the Level 04 terrace.

The Level 07 terrace has the potential to experience localised wind effects along the eastern aspect due to the funnelling of the prevailing south-easterly winds between the Council and Commercial buildings. There is also the potential for the westerly winds to accelerate around the northern and eastern corners of the terrace. It is recommended to investigate the implementation of impermeable screening (the height of which can be investigated with detailed wind tunnel testing) along the south-eastern perimeter of the terrace.

5.2.2 Commercial Building

The Level 07 terrace is noted to be exposed along the northern, eastern, southern and western aspects. The limited shielding and exposure to the three prevailing wind directions proposes potential issues at the south-eastern and north-western corners of the terrace. The north-easterly winds have the potential to be captured within the recessed terrace and side-stream along the northern aspect as they move towards the western aspect. They have the potential to formulate into corner accelerating winds at the north-western corner. It is recommended to include densely foliating evergreen hedges along the northern aspect of the terrace to assist in filtering these winds. Similarly, it is recommended to investigate the implementation of impermeable screening (the height of which can be investigated with detailed wind tunnel testing) along the western perimeter to assist in reducing the corner acceleration effects.

The southern aspect of the tower is expected to capture the prevailing south-easterly winds which have the potential to side-stream and impact the eastern most and southern most corners of the terrace. It is recommended to include densely foliating evergreen hedges along the southern aspect of the terrace to assist in filtering these winds. Similarly, it is recommended to investigate the implementation of impermeable screening (the height of which can be investigated with detailed wind tunnel testing) along the western perimeter to assist in reducing the corner acceleration effects. The presence of the Council building assists in providing moderate shielding of the prevailing westerly winds from impacting the southern aspect of the terrace.

5.3 General Recommendations

For tree planting/landscaping to be effective as a wind mitigation device, the species should be of a densely foliating variety. It is recommended that an evergreen species be selected to ensure year-round effectiveness. Trees should also be planted in clusters with interlocking canopies to effectively absorb incident winds. In sensitive areas or hotspots where strong winds are expected, mature trees should be used as immature trees have difficulty establishing themselves in strong wind conditions. If immature trees are initially planted, the inclusion of porous screens around these tree plantings, or temporary wind screens is recommended to provide some wind mitigation while the trees develop and also provide some protection as the trees establish. Conditions can be further improved through the use of low-level vegetation such as shrubs/hedges or planter boxes. When utilised below a tree canopy, they provide protection from low level winds, especially for more sensitive areas where longer duration activities are expected. In general, landscaping can help mitigate adverse wind conditions caused by winds directly impacting an area, or side streaming winds by slowing the winds upstream.

It is recommended that wind tunnel testing be undertaken at a more detailed design stage in order to quantitatively assess the wind conditions within and around the site to ensure suitable pedestrian wind conditions are satisfied.

Treatments Legend

-  Retention of proposed densely foliating, evergreen trees
-  Inclusion of densely foliating, evergreen trees
-  Recommended zone to increase planter box area
-  Area prone to possible pre-existing adverse wind conditons
-  Strategic planting to be investigated if pedestrian link is designed such that it is open on both aspects and/or exposed to external elements

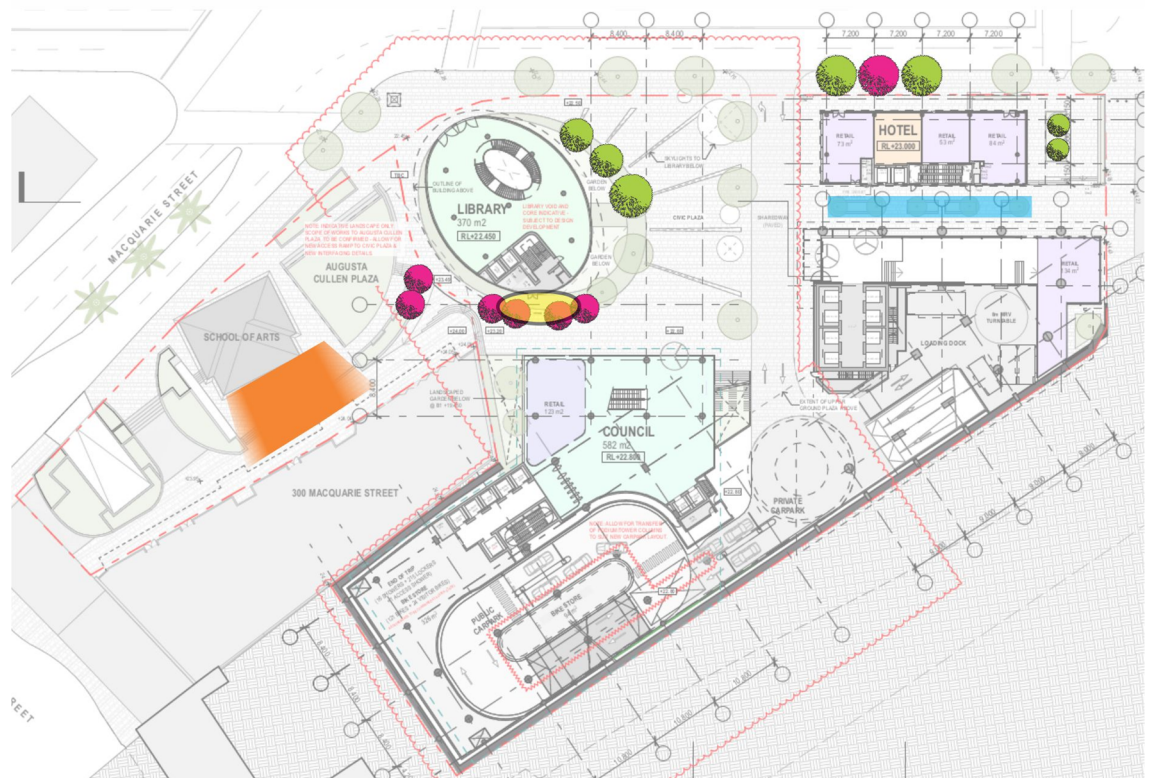
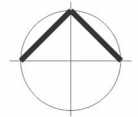


Figure 5: Recommended treatments for Lower Ground Level

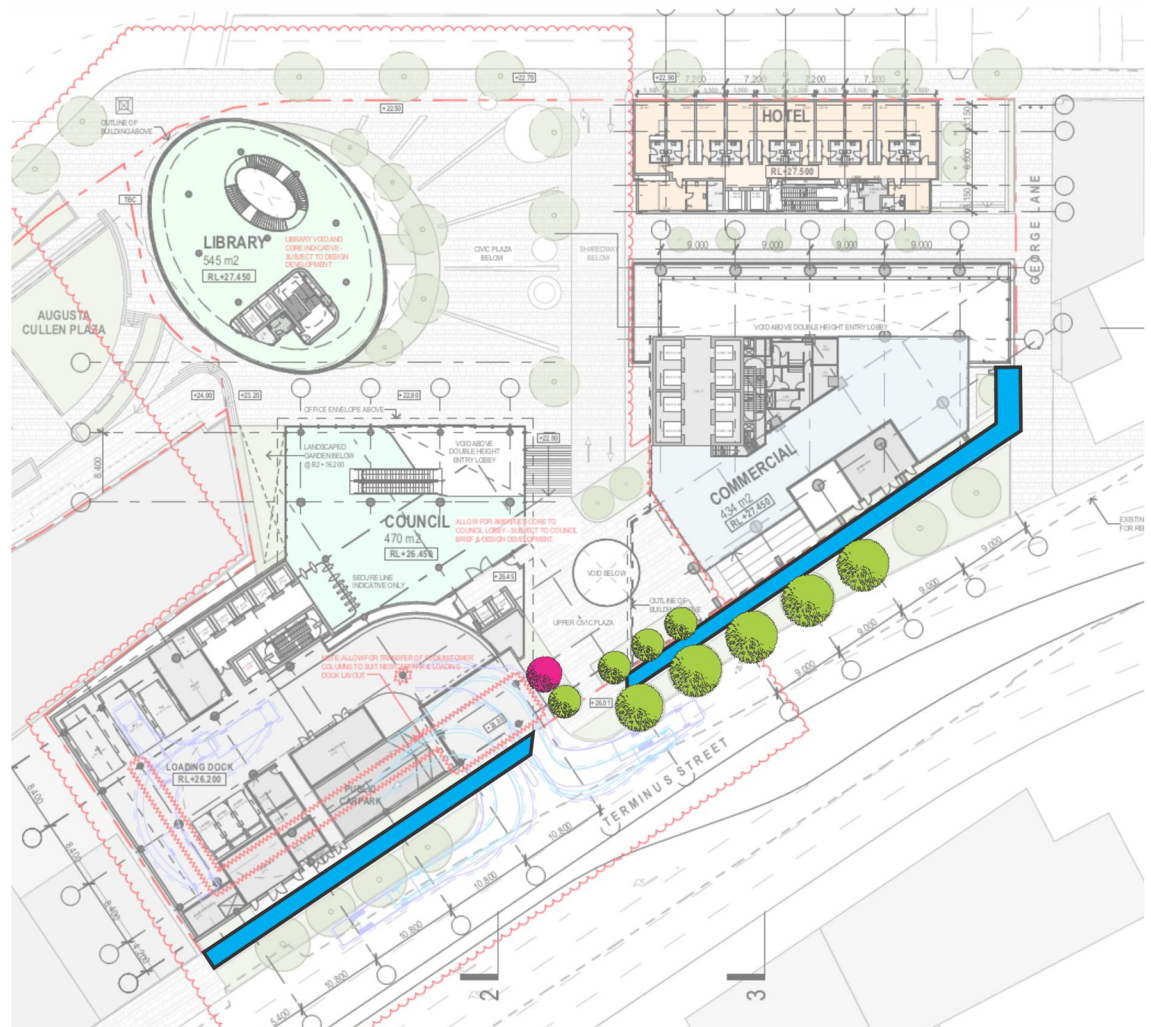


Figure 6: Recommended treatments for Upper Ground Level

Treatments Legend

■ Recommended impermeable screen
(height to be investigated during detailed wind tunnel testing)

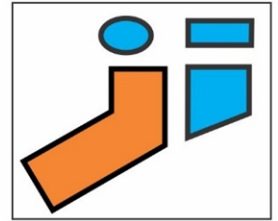


Figure 7: Recommended treatments for Level 1 – Council Building

Treatments Legend



Recommended zone to increase planter box area



Inclusion of densely foliating evergreen shrubs/planting

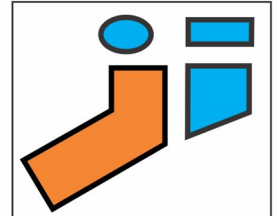


Figure 8: Recommended treatments for Level 4 – Council Building

Treatments Legend

■ Recommended impermeable screen
(height to be investigated during detailed wind tunnel testing)

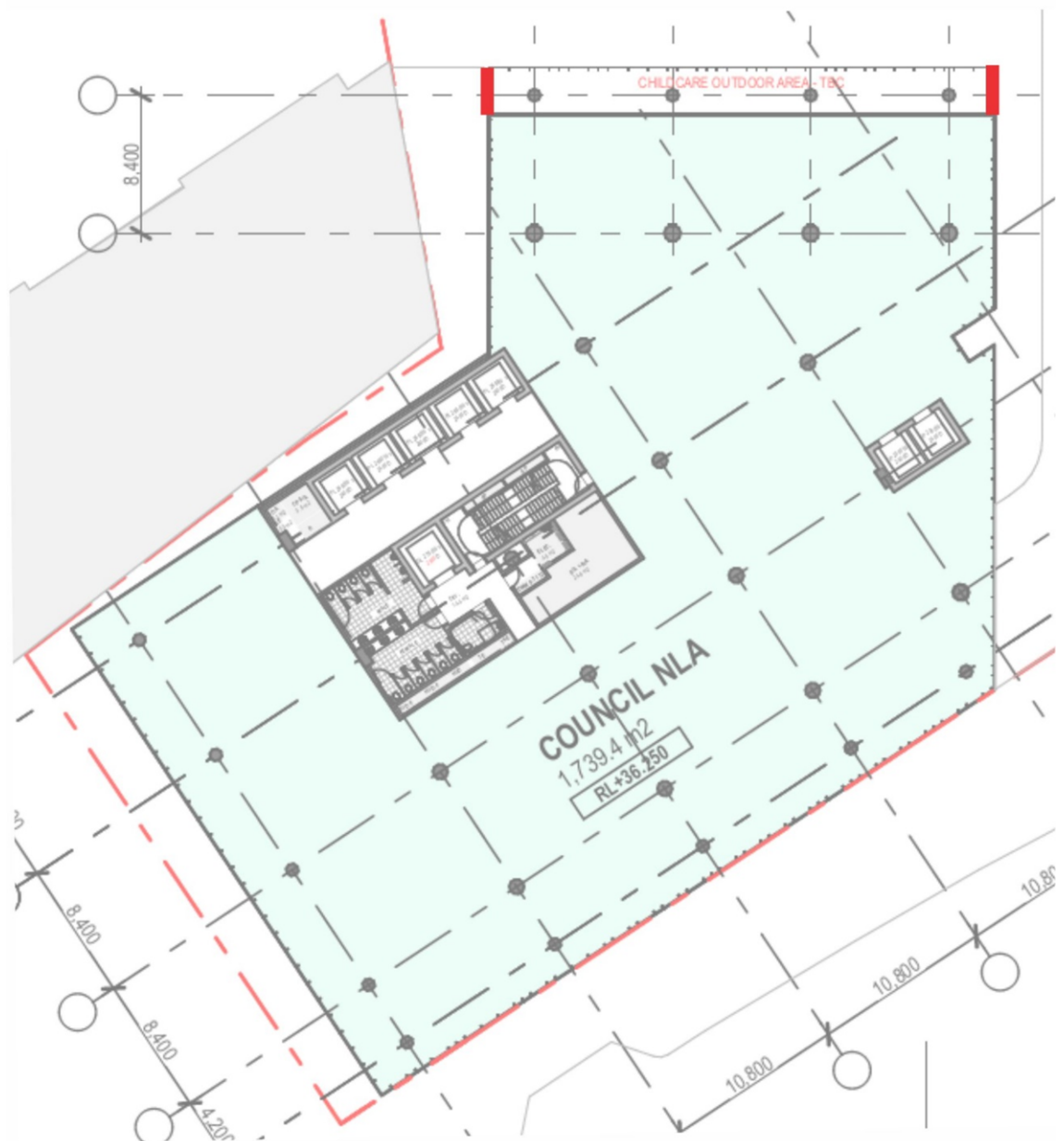
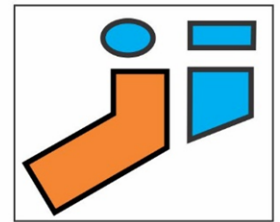


Figure 9: Recommended treatments for Level 6 – Council Building

Treatments Legend

█ Recommended impermeable screen
(height to be investigated during detailed wind tunnel testing)

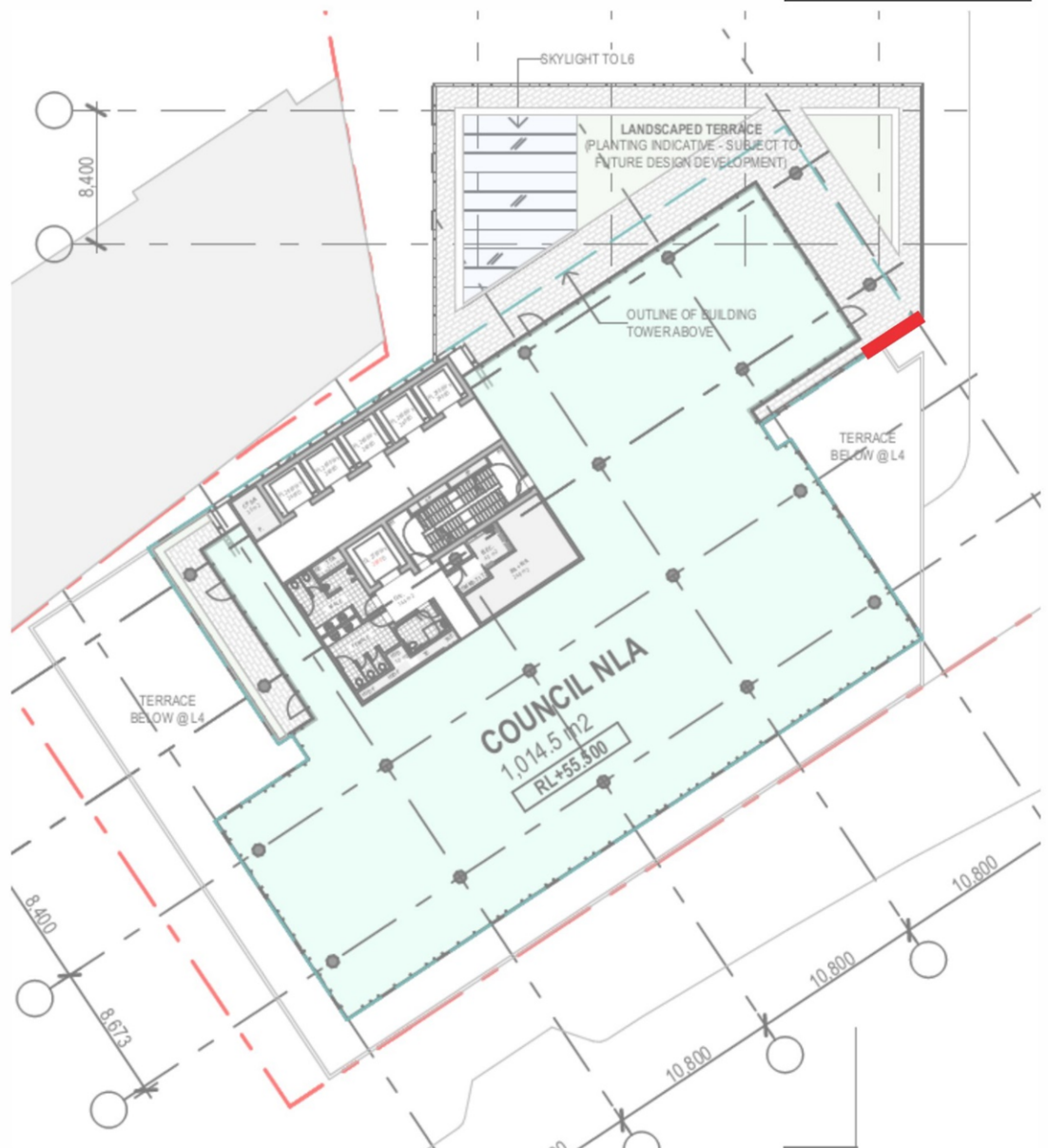
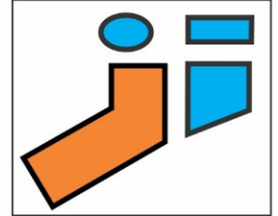


Figure 10: Recommended treatments for Level 7 – Council Building

Treatments Legend

-  Recommended impermeable screen
(height to be investigated during detailed wind tunnel testing)
-  Inclusion of densely foliating evergreen hedges

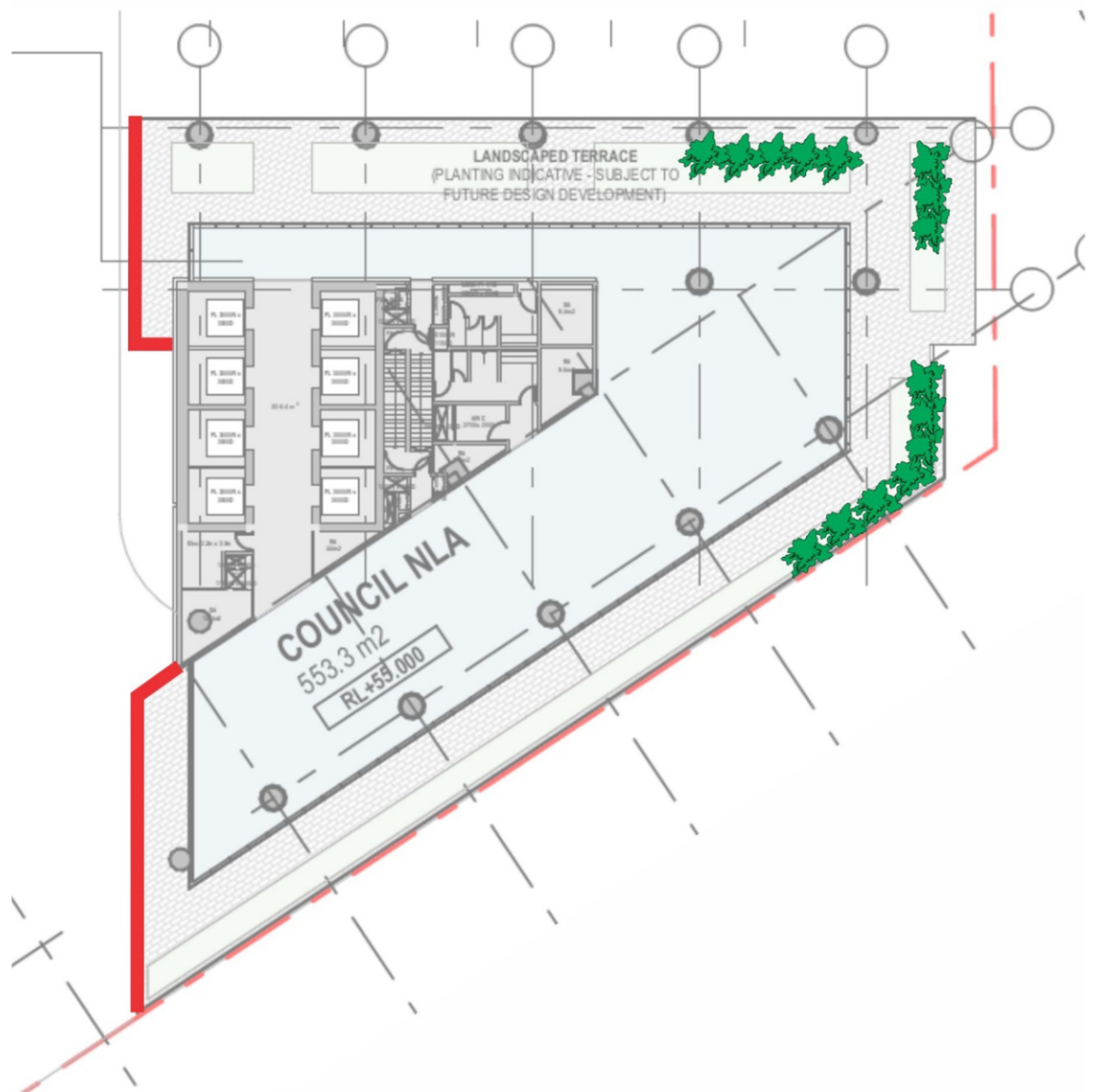
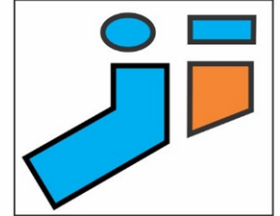


Figure 11: Recommended treatments for Level 7 – Commercial Building

6 REFERENCES

Davenport, A.G., 1972, "An approach to human comfort criteria for environmental conditions". Colloquium on Building Climatology, Stockholm.

Lawson, T.V., 1973, "The wind environment of buildings: a logical approach to the establishment of criteria". Bristol University, Department of Aeronautical Engineering.

Lawson, T.V., 1975, "The determination of the wind environment of a building complex before construction". Bristol University, Department of Aeronautical Engineering.

Lawson, T.V., 1980, "Wind Effects on Buildings - Volume 1, Design Applications". Applied Science Publishers Ltd, Ripple Road, Barking, Essex, England.

Melbourne, W.H., 1978, "Criteria for Environmental Wind Conditions". *Journal of Wind Engineering and Industrial Aerodynamics*, vol. 3, pp241-249.

Penwarden, A.D. (1973). "Acceptable Wind Speeds in Towns", *Building Science*, vol. 8: pp259–267.

Penwarden, A.D., Wise A.F.E., 1975, "Wind Environment Around Buildings". Building Research Establishment Report, London.