APPENDIX G: WIND SUPPORTING INFORMATION

APPENDIX G-1
HUB PLAN WIND STUDY

REPORT

MARKET/OCTAVIA HUB PLAN

SAN FRANCISCO, CA

PEDESTRIAN WIND STUDY

RWDI #1603628

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SUBMITTED TO

San Francisco Planning Department
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EXECUTIVE SUMMARY

The following document provides a discussion for the Pedestrian Wind Study conducted for the proposed Market/Octavia Hub Plan (project) located in San Francisco, California, USA. The wind criteria within the San Francisco Planning Code Section 148, which addresses both ground-level hazard and comfort as they relate to wind force, are also described in order to assist with the assessment of the results presented.

The study assessed four configurations of the project site and surroundings. The predicted wind comfort and hazard conditions pertaining to these four scenarios are depicted on a site plan in **Figures 1a through 2d** of the Figures section of this report.[1] These conditions and the associated wind speeds are presented in **Tables 1 and 2** of the Tables section of this report. These results are also presented in the attached results package and can be summarized as follows:

SUMMARY	Configuration	PEDESTRIAN WIND COMFORT[1]				PEDESTRIAN WIND HAZARD[2]			
		Average Wind Speed (mph)	Average percent the criterion is exceeded (%)	Speed Change (mph)	Total # of Exceedances	Average Wind Speed (mph)	Total Hours	Hours Change	Total # of Exceedances
	Existing	14	21	-	114/160	27	567	-	21/160
	Existing + Hub Plan EIR	15	25	1	125/160	29	780	213	32/160
	Cumulative 1	15	24	1	120/160	29	888	321	36/160
	Cumulative 2	15	25	1	125/160	30	1123	556	41/160

Notes:
1) Wind Comfort = Wind speeds exceeding 11 mph for 10% of the time
2) Wind Hazard = Wind speeds exceeding 36 mph for 1 hour/year[2]

Bikeway locations were tested for informational purposes pertaining to the four configurations assessed are graphically depicted on a site plan in **Figures 3a through 3d** of the Figures section of this report. These conditions and the associated wind speeds are presented in **Table 3** of the Tables section of this report.

[1] In general, any references to "images" in this report refers to graphics provided within the body of the report, while any references to "figures" throughout this text refer to graphics provided in the Figures section of this report. Similarly, references to "tables" refer to tables provided in the Tables section of this report, although some summary tables are also provided within the body of the report.
[2] How this equates to the Section 148 26mph is explained in Section 2.3.

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1 INTRODUCTION

RWDI was retained by ICF International to conduct a Pedestrian Wind assessment for the purpose of determining the effect of the Hub Plan on the wind conditions in this area of the city. The tested configurations include the individual development projects, 30 Van Ness Avenue and 98 Franklin Street, as well as the Hub Plan Programmatic Site Buildings and cumulative buildings (Hub Plan area boundary and cumulative list of buildings is shown in **Image 1**, below, , the individual development projects at 30 Van Ness Avenue and 98 Franklin Street are shown in red).

1.1 Project Description

1.1.1 The Hub Plan

The Hub Plan seeks to encourage housing, especially affordable housing; create safer and more walkable streets as well as welcoming and active public spaces; increase transportation options; and create a complete neighborhood with a range of uses and services to meet neighborhood needs. The Hub Plan would pursue this vision through changes to current zoning controls applicable to the area, to better meet plan objectives. This would include changes to height and bulk districts for select parcels to allow more housing, including more affordable housing. Under the proposed zoning, there would be two zoning districts, Downtown General Commercial (C-3-G) and Public (P). The Van Ness and Market Downtown Residential Special Use District would also be expanded to encompass the entire Hub Plan area. Modifications to zoning controls would also allow more flexibility for development of nonresidential uses, specifically office, institutional, art, and public uses. The plan also calls for public realm improvements to streets and alleys within and adjacent to the Hub Plan area. Requirements for micro retail would encourage a mix of retail sizes and uses.

The Hub Plan area is irregular in shape and is bounded by Haight Street just east of its intersection with Octavia Boulevard to Gough Street, Gough Street from Haight Street to Page Street, Page Street from Gough Street to Franklin Street, Franklin Street from Page Street to Fell Street, Fell Street from Franklin Street to Van Ness Avenue, Van Ness Avenue from Fell Street to Hayes Street, Hayes Street from Van Ness Avenue to the intersection of Larkin Street, Ninth Street and Market Street, Market Street from Ninth Street to approximately midblock between 10th and 11th streets, mid-block from between 10th Street and 11th Street from Market Street to Mission Street, Mission Street from 10th Street to Washburn Street, a portion of Washburn Street between Mission Street and Howard Street and then to the intersection of 10th Street and Minna Street, Minna Street from 10th Street to just past Lafayette Street (with certain lots excluded), mid-block between Lafayette Street and 12th Street to Howard Street, Howard Street between just north of 12th Street to 13th Street, and 13th Street to Haight Street just east of the intersection of Octavia Boulevard and Haight Street, as shown in **Image 1**. In addition to the streets in the Hub Plan area, the project includes adjacent streets such as Lily Street between Gough Street and Franklin Street, Minna Street between 10th Street and Lafayette Street, and Duboce Avenue between Valencia Street and Mission Street.

1.1.2 Individual Projects

Two individual development projects included within the Hub Plan area are included for the plan-level analysis but have separate project-specific reports (see Appendix B). The proposed project at 30 Van Ness Avenue includes retention of portions of the existing building and construction of a 47-story building with ground-floor commercial space, up to 11 floors of office space, and 35 floors of residential space.

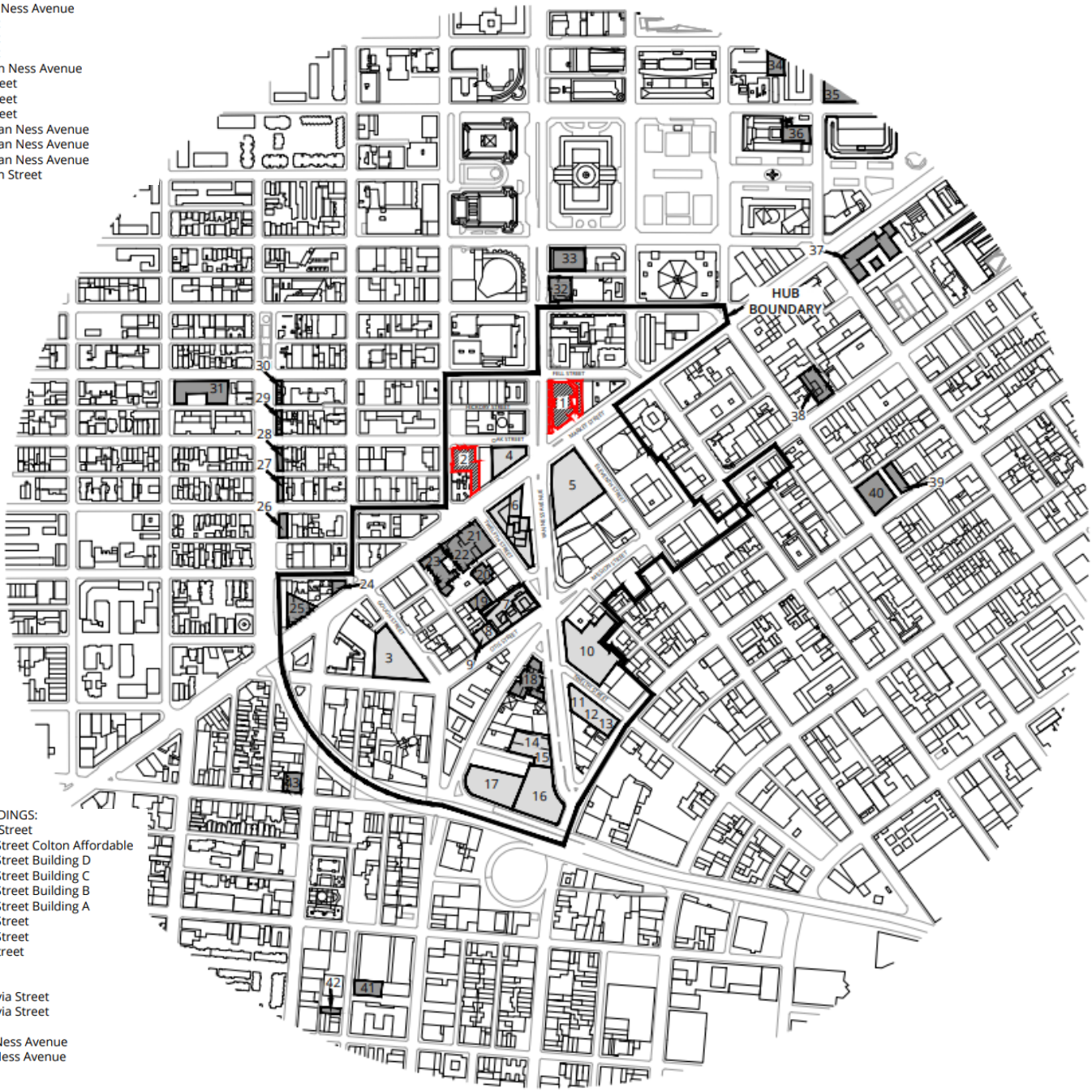
The proposed project at 98 Franklin Street includes demolition of the existing surface parking lot and construction of a 31-story residential tower above a five-story podium that would serve as the new high school facilities for grades 9-12 of the French American International School. Additionally, the 98 Franklin Street project proposes certain streetscape improvements to Lily Street and Oak Street.

1.2 Objectives

The purpose of the study is to assess the wind environment around the Hub Plan area in terms of pedestrian comfort and safety. This quantitative assessment was based on wind speed measurements on a 1:400 scale model of the Project and its surroundings (**Image 1**) in a boundary-layer wind tunnel.

INDIVIDUAL PROJECT SITE BUILDINGS:
1: 30 Van Ness Avenue
2: 98 Franklin Street

HUB PLAN PROGRAMMATIC SITE BUILDINGS:
3: 33 Gough Street
4: 1500-1540 Market Street
5: 1 South Van Ness Avenue
6: 10 South Van Ness Avenue
7: 30 Otis Street
8: 42 Otis Street
9: 50 Otis Street
10: 99 South Van Ness Avenue
11: 110 12th Street
12: 180 12th Street
13: 194 12th Street
14: 154 South Van Ness Avenue
15: 160 South Van Ness Avenue
16: 170 South Van Ness Avenue
17: 1695 Mission Street



CUMULATIVE BUILDINGS:
18. 1601 Mission Street
19. 1629 Market Street Colton Affordable
20. 1629 Market Street Building D
21. 1629 Market Street Building C
22. 1629 Market Street Building B
23. 1629 Market Street Building A
24. 1700 Market Street
25. 1740 Market Street
26. 188 Octavia Street
27. Parcel R.
28. Parcel S.
29. 300-350 Octavia Street
30. 300-350 Octavia Street
31. 455 Fell St
32. 200-214 Van Ness Avenue
33. Grove + Van Ness Avenue
34. UC Hastings
35. UC Hastings
36. 45 Hyde Street
37. Trinity Place
38. 1270 Mission Street
39. 1298 Howard
40. 1298 Howard
41. 49 Julian
42. 80 Julian
43. 198 Valencia

Image 1: Site Plan – Hub Plan Area

2 BACKGROUND AND APPROACH

2.1 Wind Tunnel Study Model

To assess the wind environment around the Hub Plan area, a 1:400 scale model of the site and surroundings was constructed for the wind tunnel test with the following configurations tested:

A – Existing: Existing site with existing surroundings, including buildings that are under-construction as of April 11, 2018, with Van Ness Avenue Bus Rapid Transit (BRT) landscaping (i.e., trees) and station structures, and existing landscaping included along Van Ness Avenue in the project area (**Image 2a**). Landscaping has been included in all configurations to better represent the true wind conditions of the tested areas.

B – Existing + Hub Plan: Configuration A with existing landscaping switched to proposed landscaping in front of 30 Van Ness Avenue (proposed trees assumed to be deciduous at 5-10 years of growth and 10-15ft canopy) and the following study buildings included (**Image 2b and Appendix A**):

Plans on File:
30 Van Ness Avenue (rec'd Sep 10, 2018)
98 Franklin Street (rec'd Sep 7, 2018)
10 South Van Ness Avenue – 590 ft. Single Tower (rec'd Apr 4, 2018)
Massing provided by Planning Department:
1 South Van Ness Avenue (Appendix A)

Plans on file but with a more general/rounded form ("wedding cake" look), height extrapolated to full maximum height under the Hub Plan:
1500-1540 Market Street (One Oak) - 450 ft.
42 Otis Street – 65 ft.
30 Otis Street – 320 ft.

Full site boundary, height extrapolated to full maximum under the Hub Plan (Table 1 of Appendix A):
50 Otis Street
99 South Van Ness Avenue
33 Gough Street
110 12th Street
180 12th Street
194 12th Street
154 South Van Ness Avenue
160 South Van Ness Avenue
170 South Van Ness Avenue
1695 Mission Street Avenue

C – Cumulative 1: Configuration B plus all cumulative buildings shown in **Image 2c** below and listed in **Image 1** on page 3.

D – Cumulative 2: Configuration C with 10 South Van Ness Avenue changed to double tower buildings at 400 ft. tall, as shown in **Image 2d** and **Image 1** on page 3.

The scale model of the study buildings (as shown in **Images 2b** through **2d**) was constructed using the information outlined by the San Francisco Planning Department in ***Appendix A***. The wind tunnel model included all relevant surrounding buildings and topography within an approximately 3,200 ft (0.6 mile) radius of the study area. The boundary-layer wind conditions beyond the modelled area were also simulated in RWDI's wind tunnel. The wind tunnel model was instrumented with 160 wind speed sensors (Figures 1 and 2) to measure mean and gust wind speeds at a full-scale height of approximately 5 feet (ft). The model was also instrumented with 18 bicycle lane locations (Figures 3) for informational purposes. The placement of wind measurement locations was based on our experience and understanding of the pedestrian usage for this site, and reviewed by the San Francisco Planning Department. These measurements were recorded for 16 equally incremented wind directions.

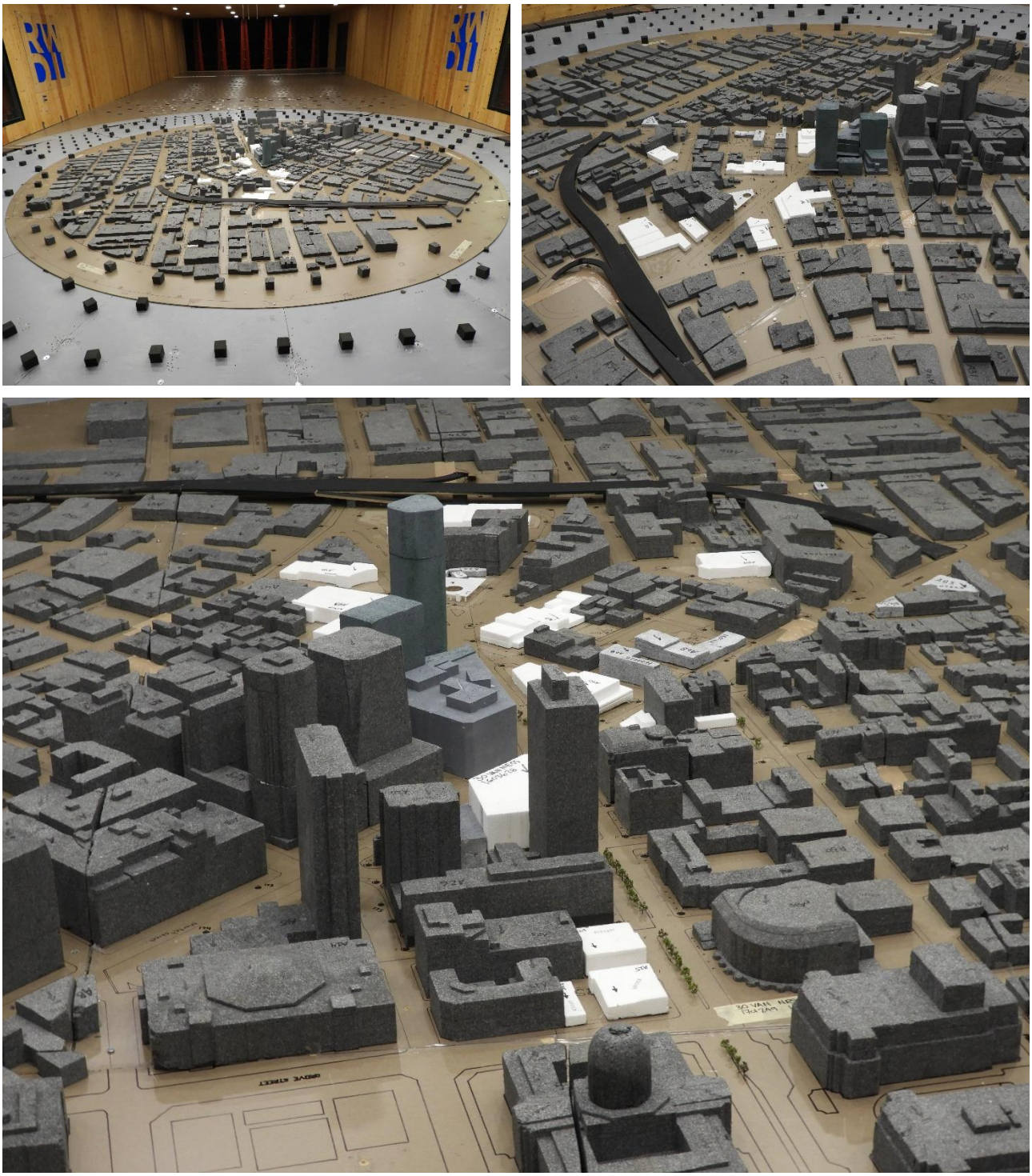


Image 2a: Wind tunnel study model – Existing configuration

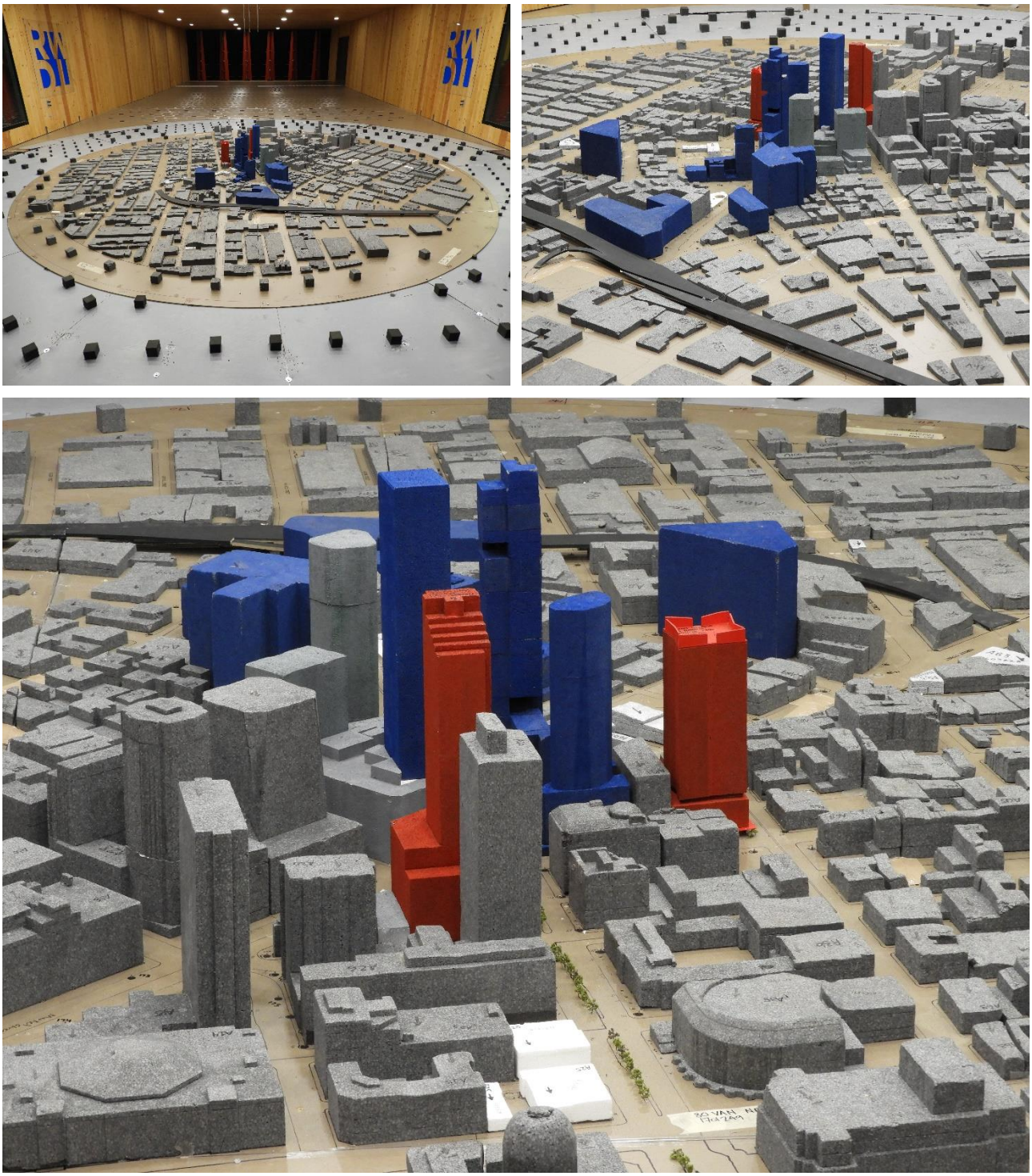


Image 2b: Wind tunnel study model – Existing + Hub Plan EIR configuration

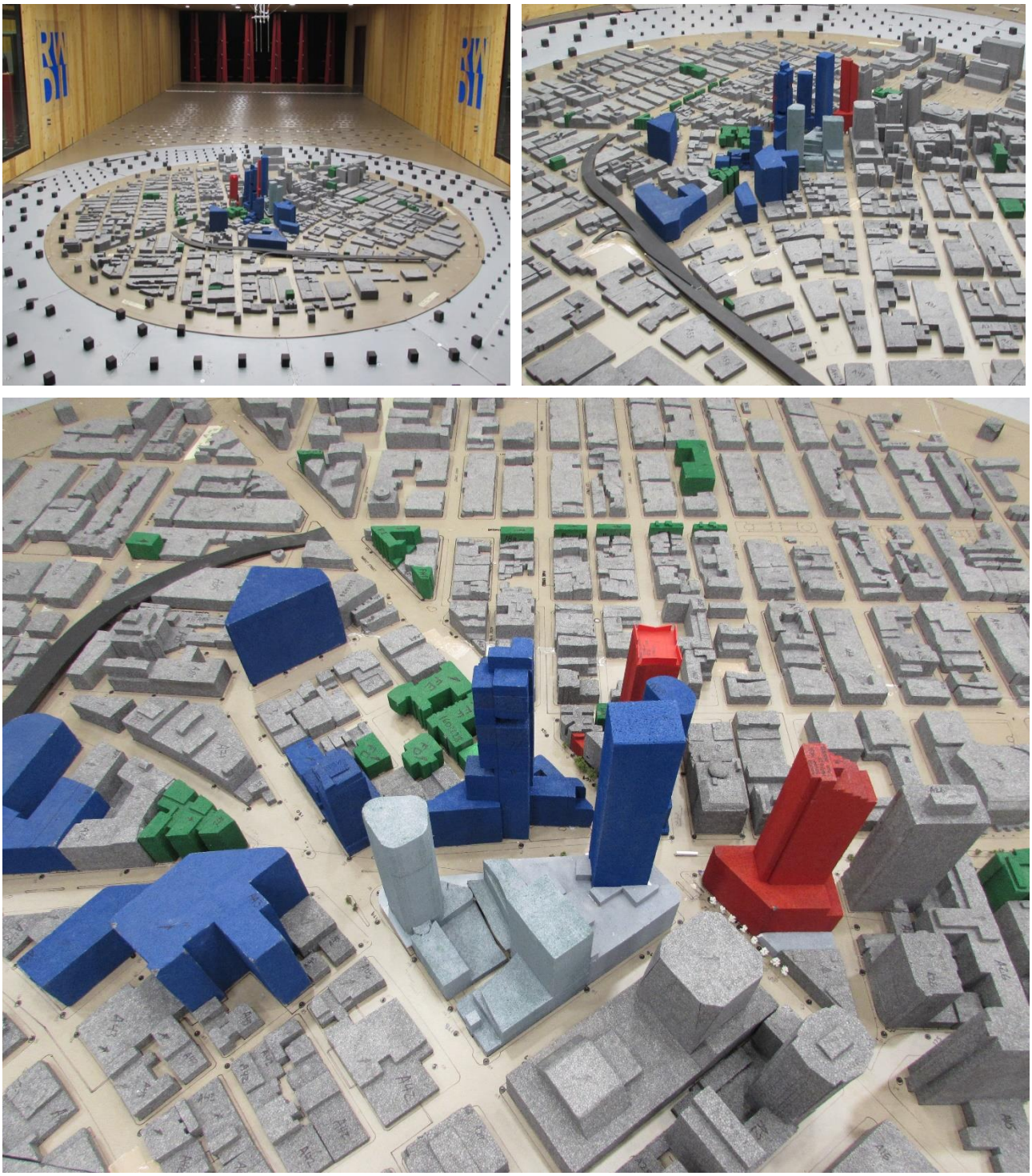


Image 2c: Wind tunnel study model – Cumulative 1 configuration

Image 2d: Wind tunnel study model – Cumulative 2 configuration

2.2 Meteorological Data

Wind statistics recorded at the San Francisco Federal Building between 1945 and 1951 (at a height of 132 ft.) were analyzed as a reference for local climate and describe the speed, direction, and frequency of occurrence of winds. Wind statistics were combined with the wind tunnel data to predict the frequency of occurrence of full-scale wind speeds. The full-scale wind predictions were then compared against the wind comfort and hazard criteria as stated in the San Francisco Planning Code Section 148 (See ***Appendix B***).

Average wind speeds in San Francisco are the highest in the summer and lowest in winter. However, the strongest peak winds occur in winter. Throughout the year the highest wind speeds occur in mid-afternoon and the lowest in the early morning. Westerly to northwesterly winds are the most frequent and strongest winds during all seasons. Of the primary wind directions, four have the greatest frequency of occurrence and make up the majority of the strong winds that occur. These winds include the northwest, west-northwest, west and west-southwest.

2.3 San Francisco Planning Code Section 148

San Francisco has established wind comfort and hazard criteria to be used in the evaluation of a proposed development. San Francisco Planning Code Section 148, Reduction of Ground Level Wind Currents, outlines wind reduction criteria for the Downtown Commercial (C-3) districts. Though certain portions of the Hub Area are not located in a C-3 District, the City uses the wind hazard criterion from Planning Code Section 148 to evaluate the significance of wind impacts from all proposed projects for the purposes of CEQA.

a) Requirement and Exception. In C-3 Districts, buildings and additions to existing buildings shall be shaped, or other wind-baffling measures shall be adopted, so that the developments will not cause ground-level wind currents to exceed, more than 10 percent of the time year-round, between 7:00 a.m. and 6:00 p.m., the comfort level of 11 mph equivalent wind speed in areas of substantial pedestrian use and 7 mph equivalent wind speed in public seating areas.

   When pre-existing ambient wind speeds exceed the comfort level, or when a proposed building or addition may cause ambient wind speeds to exceed the comfort level, the building shall be designed to reduce the ambient wind speeds to meet the requirements. An exception may be granted, in accordance with the provisions of Section 309, allowing the building or addition to add to the amount of time that the comfort level is exceed by the least practical amount if (1) it can be shown that a building or addition cannot be shaped and other wind-baffling measures cannot be adopted to meet the foregoing requirements without creating an unattractive and ungainly building form and without unduly restricting the development potential of the building site in question, and (2) it is concluded that, because of the limited amount by which the comfort level is exceeded, the limited location in which the comfort level is exceeded, or the limited time during which the comfort level is exceeded, the addition is insubstantial. No exception shall be granted and no building or addition shall be permitted that causes equivalent wind speeds to reach or exceed the hazard level of 26 miles per hour for a single hour of the year.

b) Definition. The term "equivalent wind speed" shall mean an annual hourly mean wind speed adjusted to incorporate the effects of gustiness or turbulence on pedestrians.

c) Guidelines. Procedures and Methodologies for implementing this section shall be specified by the Office of Environmental Review of the Department of City Planning. (added by Ord. 414-85, App. 9/17/85)

The analysis of the wind effects of the Hub Plan were performed using the wind testing analysis and evaluation methods that are used for Section 148.

The threshold wind speeds in the Planning Code were established by assuming wind speeds were averaged for one hour, while the local wind data available from the old San Francisco Federal Building at 50 United Nations Plaza were recorded for one minute on each hour. Therefore, an equivalent wind speed of 36 mph (based on the actual one-minute averaged meteorological data), instead of the Planning Code value of 26 mph (based on the assumed one-hour averaged meteorological data), is commonly used in San Francisco for the assessment of hazardous winds. The wind tunnel test results presented in this report use the one-minute average of 36 mph as the wind hazard criterion.

2.4 Under-Construction and Cumulative Buildings

Buildings in the surrounding area that are under construction and/or have been approved were modeled in accordance with the information received in April 2018 from the San Francisco Planning Department. Buildings within the study radius that are currently under construction were included in all test configurations (i.e., existing conditions). Anticipated future buildings that had not begun construction as of April 2018 were included in the Cumulative configurations. These sites are shown and listed in **Image 1** as Cumulative Buildings.

3 RESULTS AND DISCUSSION

This section presents the results of the wind tunnel measurements analyzed in terms of equivalent wind speeds as defined in Section 2.3. The text of the report simply refers to the data as wind speeds.

The wind comfort results for the four tested configurations are graphically depicted on a site plan in Figures 1a through 1d located in the "Figures" section of this report where locations have been color-coded according to the Planning Code's 7-mph and 11-mph comfort criteria. This same data is also numerically depicted in Table 1, located in the "Tables" section of this report. For each measurement point, the measured 10% exceeded (90^{th} percentile) equivalent wind speed and the percentage of time that the wind speed exceeds 11 mph are listed. The point is marked as a comfort exceedance if the 11-mph threshold is exceeded. A letter "e" in the last column of each configuration indicates a wind comfort exceedance.

According to the San Francisco wind comfort criterion, locations with wind speeds that exceed the 11 mph are considered uncomfortable for any use. Locations with wind speeds between 7-11 mph are comfortable for sidewalks and locations with wind speeds lower than 7 mph are suitable for any area including entrances, seating areas and bus stops.

Table 2 in the Tables section of this report presents the wind hazard results, and lists the predicted wind speed to be exceeded one hour per year. The predicted number of hours per year that the Section 148 wind hazard criterion (one-minute wind speed of 36 mph) is exceeded is also provided. A letter "e" in the last column of each

configuration indicates a wind hazard exceedance. Figures 2a through 2d depict these locations on and around the project site and can be summarized in the following table.

SUMMARY	Configuration	PEDESTRIAN WIND COMFORT[1]				PEDESTRIAN WIND HAZARD[2]			
		Average Wind Speed (mph)	Average percent the criterion is exceeded (%)	Speed Change (mph)	Total # of Exceedances	Average Wind Speed (mph)	Total Hours	Hours Change	Total # of Exceedances
	Existing	14	21	-	114/160	27	567	-	21/160
	Existing + Hub Plan EIR	15	25	1	125/160	29	780	213	32/160
	Cumulative 1	15	24	1	120/160	29	888	321	36/160
	Cumulative 2	15	25	1	125/160	30	1123	556	41/160

Notes:
1) Wind Comfort = Wind speeds exceeding 11 mph for 10% of the time
2) Wind Hazard = Wind speeds exceeding 36 mph for 1hour/year[3]

Table 3 presents the results at the bikeway locations Figures 3a through 3d depicts these locations on and around the project site.

3.1 A - Existing Configuration

For the Existing configuration, the average 90th percentile wind speed for the 160 test locations is approximately 14 mph. Wind speeds at 114 of 160 test locations exceed the Planning Code's pedestrian-comfort criterion of 11 mph. Winds currently exceed the applicable criterion 21% of the time (Table 1 and Figure 1a). The corner of Fell and Polk Streets contains a seating area where the comfort criterion of 11mph is exceeded for 51% of the time in the Existing configuration (Location 10, Figure 1a). The existing landscaping at this location was not tested. Therefore, conditions at this location are expected to be improved with the landscaping in place, although they are not expected to be comfortable for sitting.

Under the Existing scenario, the wind hazard criterion is currently exceeded at 21 of the 160 test locations for a total of 567 hours (Table 2 and Figure 2a). Twelve of the 21 test locations that exceed the hazard criterion are to the north of Market Street, along Fell Street and Hayes Street. The remaining locations are clustered at the intersections of Mission Street and South Van Ness Avenue and Otis Street and Gough Street, with individual locations also located along Market Street and Eleventh Street. The existing landscaping included in front of 98 Franklin Street and 30 Van Ness Avenue, both of which were tested in the Existing Configuration, provides localized wind attenuation. Without this landscaping, localized wind speeds would increase. As landscaping is present in all configurations, it is not expected to alter the net difference between the results from the Existing configuration and Project configurations.

[3] How this equates to the Section 148 26mph is explained in the body of the report.

3.2 B - Existing + Hub Plan Configuration

Compared to the Existing configuration, the addition of the Hub Plan project would result in similar wind comfort conditions around the Hub Plan area. The average 90th percentile wind speed for the 160 test locations would be 15 mph, an increase of 1 mph over existing conditions. The wind speeds at a total of 125 test locations (Figure 1b), an increase of 11 test locations as compared to the existing conditions, would exceed the Planning Code's pedestrian-comfort criterion of 11 mph. Winds would exceed the 11-mph criterion approximately 25% of the time, representing a 4% increase (Table 1). The wind conditions at Location 10 would be unaffected by the addition of the Hub Plan buildings.

The addition of the Hub Plan project would result in 32 locations that exceed the 1-hour per year hazard criterion, or 11 more locations as compared to existing conditions. The total number of hours per year where winds would exceed the applicable hazard criterion increases by an additional 213 hours when compared to the Existing configuration (Table 2 and Figure 2b), for a total of 780 hours. The majority of the new exceedances occur to the north and south of 33 Gough Street, around all faces of 1 South Van Ness, along South Van Ness Avenue, and generally near the interaction of Van Ness Avenue and Market Street. Uses of these areas include sidewalks, building entrances, and bus stops.

Upon completion of wind tunnel testing, an additional site was added to the Hub Plan project at 170 Otis Street. The 170 Otis Street site currently contains an existing eight-story office building and is split between 85-X and 125-X height and bulk zoning districts. The sponsor proposes shifting the 125-X zoning to a different portion of the site to better align it with the footprint of the current office building, which has a height of approximately 110 to 125 ft. Additionally, the proposed rezoning at 170 Otis Street would create a 45-X height and bulk-zoned buffer on the west side of the site. The 170 Otis Street site is located in the path of the accelerated wind stream of 33 Gough Street. Therefore, if 33 Gough Street is not refined from the tested massing, wind conditions around 170 Otis Street are expected to be uncomfortable or maybe even hazardous in the presence of the proposed 33 Gough Street. Wind conditions around 170 Otis Street are not expected to be affected by the proposed changes to the 170 Otis Street massing as described, and therefore, there would not be any new or additional exceedance locations as a result of the 170 Otis Street massing.

3.3 C - Cumulative 1 Configuration

The addition of the approved cumulative (future) developments in the surrounding area would provide wind speeds similar to the Existing and Existing + Hub Plan EIR configurations. The average 90th percentile wind speed for the 160 test locations would remain at 15 mph, with the wind speeds at 120 test locations exceeding the Planning Code's pedestrian-comfort criterion of 11 mph. Winds would exceed the criterion approximately 24% of the time, representing a 3% increase from the Existing Configuration (Table 1).

For the Cumulative 1 configuration, the total number of locations exceeding the 1-hour wind hazard criterion would be 36, 15 more locations resulting in an additional 321 hours per year when compared to the Existing configuration, for a total of 888 hours (Table 2). The new locations resulting from the Cumulative 1 Configuration are in mostly in the same locations as the Existing + Hub Plan configuration with the exception of Locations 1, 34 and 132, and additionally at 10 South Van Ness (Location 92) and 1601 Mission Street (Locations 121, 133, 134 and 155).

3.4 D - Cumulative 2 Configuration

With the change of the 10 South Van Ness Avenue massing from a single 590-foot tower to two 400 ft double towers, the average 90th percentile wind speed for the 160 test locations would be approximately 15 mph. Wind speeds at 125 locations would exceed the Planning Code's pedestrian-comfort criterion of 11 mph, slightly higher than the Cumulative 1 configuration. Winds would exceed the applicable criterion 25% of the time, representing a 4% increase when compared to the Existing Configuration (Table 1).

The wind hazard criterion would be exceeded at 41 locations for the Cumulative 2 configuration (Table 2 and Figure 2d), 20 more than the Existing Configuration. The total number of hours per year where winds would exceed the hazard criterion is 556 more than the Existing configuration, for a total of 1,123 hours (Table 2 and Figure 2d). When compared to the Cumulative 1 Configuration, one exceedance location at the corner of 33 Gough Street is improved (Location 59) and the additional exceedance locations are located around the 10 South Van Ness Avenue double tower location, and to the south along South Van Ness Avenue (Locations 93, 95, 96, and 156).

3.5 Bicycle Lanes

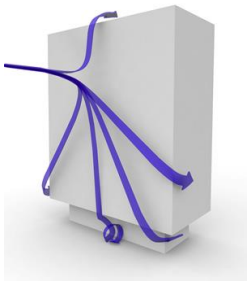
Wind speeds in existing and proposed bicycle lanes were measured for informational purposes. Wind conditions in bicycle lanes are not used to determine the significance of a proposed project's wind impacts under CEQA.

4 IN ALL TESTEDCONFIGURATIONS, THE AVERAGE WIND SPEED FOR ALL TEST LOCATIONS IS 8 MPH. WIND REDUCTION AND DESIGN GUIDELINES

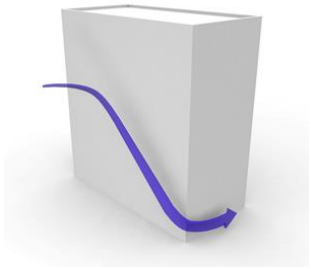
The addition of project-related buildings to a site is likely to result in a reduction in wind speeds on the leeward side of buildings (east side in this case) as the buildings would shelter the leeward side from winds. On the windward side, buildings would intercept, deflect and redirect winds and result in increased wind activity. The following is a discussion of these generalized wind phenomenon:

- Tall buildings tend to intercept the stronger winds at higher elevations and redirect them to the ground level (**Image 3.1**). Such a ***Downwashing Flow*** is often the main cause for wind accelerations around large buildings at the pedestrian level.
- When winds approach at an oblique angle to a tall façade and are deflected down, a localized increase in the wind activity or ***Corner Acceleration*** can be expected around the exposed building corner at pedestrian level (**Image 3.2**).
- When two buildings are situated side by side, wind flow tends to accelerate through the space between the buildings due to ***Channeling Effect*** caused by the narrow gap (**Image 3.3**).

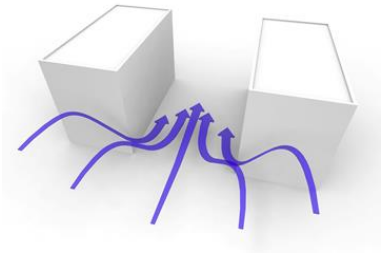
When these building/wind combinations occur for prevailing winds, particularly in an already windy area like the Hub Plan area, there is a greater potential for increased wind activity. Design details like setting back a tall tower from the edges of a podium, deep canopies close to ground level, wind screens, tall trees with dense landscaping, etc. can help reduce wind speeds to a large extent (**Images 3.4 and 3.5**). The choice and effectiveness of these measures would depend on the exposure and orientation of the site with respect to the prevailing wind directions and the size and massing of the proposed buildings.



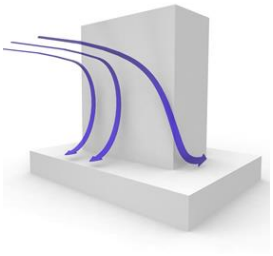
1) Downwashing flow



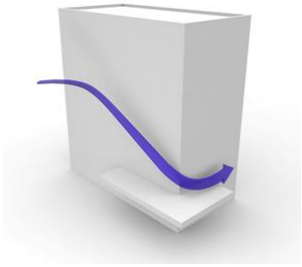
2) Corner acceleration

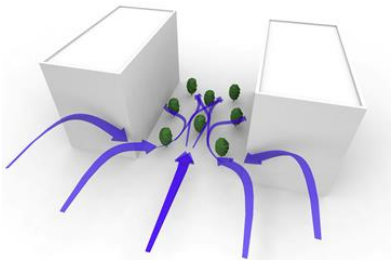


3) Channeling effect



4) Podium/tower setbacks and canopies reduce effect of downwashing at ground level





5) Landscaping reduces vertical and horizontal wind accelerations

Image 3: General wind patterns and wind control measures

Large scale measures like tower re-shaping and refinement may be required to the buildings in the Hub Plan area due to high winds. These refinements can include:

- Rounded, re-entrant[4] (top left image of **Image 4**) or chamfered building corners[5] (bottom right image of **Image 4**), as they are more aerodynamic than sharp 90-degree corners, in that the modified corner profiles disrupts wind acceleration at building corners.
- Stepped facades – vertical steps in the massing to help disrupt downwashing flows.
- Covered walkways, colonnades or street art that would provide a sheltered area for pedestrians to walk.
- Staggered arrangement of balcony slabs that project out of the main tower façade – a uniform arrangement of balconies is ineffective against strong winds as the balconies get pressurized and the uniform pockets of air would in effect behave like a solid wall. A staggered arrangement would be more beneficial in disrupting vertical wind flows along tower façades.

[4] Re-entrant corners are any inside corner that forms an angle of 180° or less.
[5] A chamfer is a 45° sloped or angled corner or edge.

Examples of the features listed are provided **in Images 4 and 5**.

Image 4: Examples of Stepped facades and Modified Building Corners

Image 5: Examples of Walkways Sheltered by a Canopy, Overhang or Street Art

Localized wind screens or landscaping that slows winds along sidewalks and protects places where pedestrians are expected to gather or linger can also be effective. These localized measures should be placed to the west of the areas of concern Landscaping typically affects winds locally - the larger the tree crown and canopy, the greater the area of influence. Tall, slender trees with little foliage have little to no effect on local winds speeds at ground level because of the height of the foliage above ground. Shorter street trees with larger canopies help reduce winds around them but their influence on conditions farther away is limited.

Solid windscreens have a greater effect at reducing the wind speeds to immediate leeward side of the screens, however, outside of this area of influence, the winds are either unaffected or accelerated. Porous windscreens have less of an effect to the immediate leeward side. However, they have an increased area of influence and are less likely to cause any accelerations of the winds further downwind.

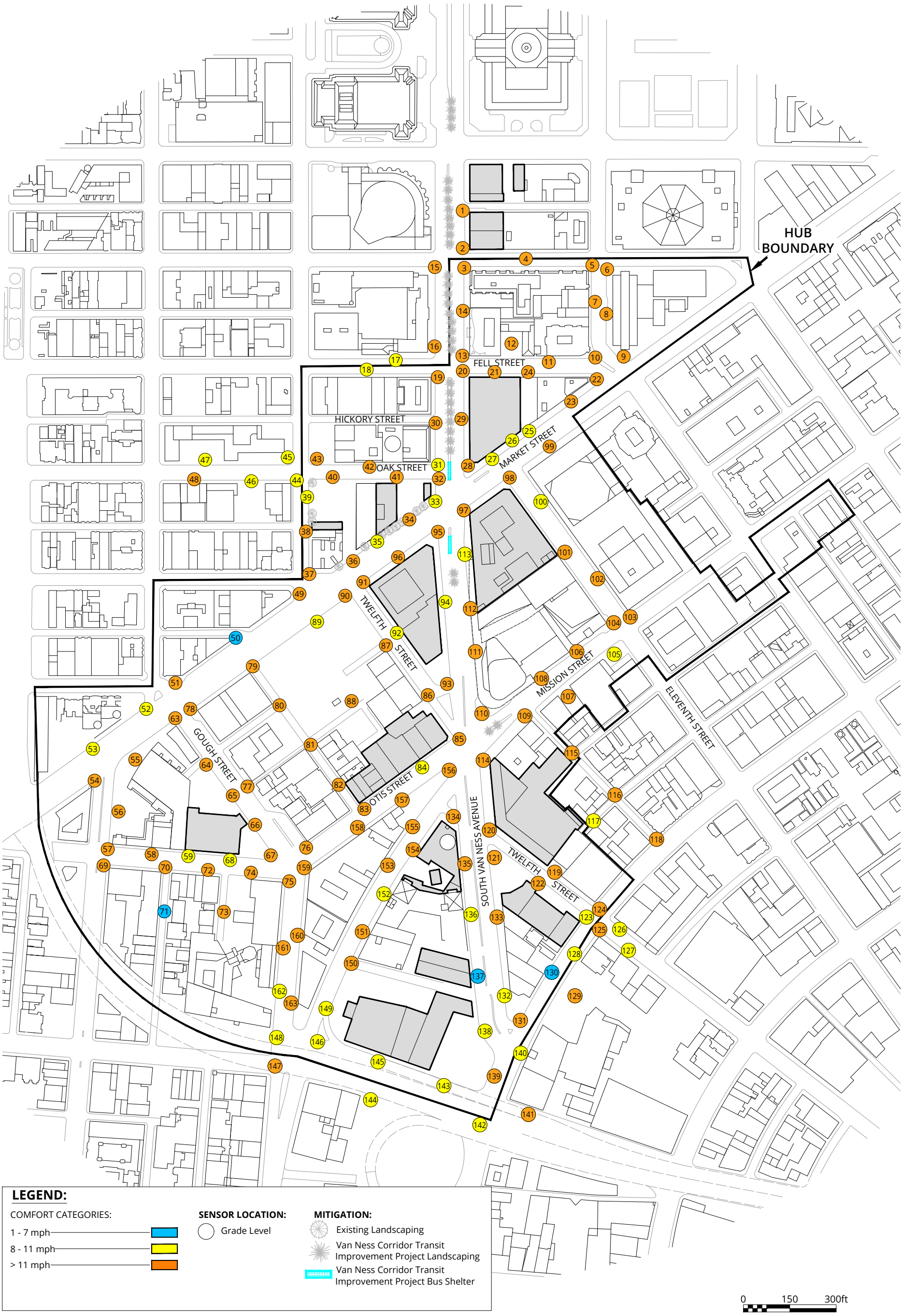
Examples of effective localized wind reduction measures are shown in **Image 6**.

Image 6: Examples of Localized Mitigation Measures

5 CONCLUSIONS

The wind conditions presented in this report pertain to the proposed Hub Plan project as detailed in the San Francisco Planning Department Memo, dated August 7, 2018 (Appendix A) and the addition of 170 Otis Street information received Nov 29, 2018. Should there be any design changes that deviate from this list of drawings, the wind condition predictions presented may change. Therefore, if changes in the design are made, it is recommended that RWDI be contacted and requested to review their potential effects on wind conditions.

FIGURES



Pedestrian Wind Comfort Conditions
Existing
Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 1a
Approx. Scale:	1"=300'
Date Revised:	Dec. 5, 2018

INDIVIDUAL PROJECT SITE BUILDINGS:
1: 30 Van Ness Avenue
2: 98 Franklin Street

HUB PLAN PROGRAMMATIC SITE BUILDINGS:
3. 33 Gough Street
4: 1500-1540 Market Street
5: 1 South Van Ness Avenue (DWG on File)
6: 10 South Van Ness Avenue (Single Tower)
7: 30 Otis Street
8: 42 Otis Street
9: 50 Otis Street
10: 99 South Van Ness Avenue
11: 110 12th Street
12: 180 12th Street
13: 194 12th Street
14: 154 South Van Ness Avenue
15: 160 South Van Ness Avenue
16: 170 South Van Ness Avenue
17: 1695 Mission Street

HUB BOUNDARY
FELL STREET
HICKORY STREET
OAK STREET
MARKET STREET
TWELFTH STREET
MISSION STREET
ELEVENTH STREET
GOUGH STREET
OTIS STREET
SOUTH VAN NESS AVENUE

LEGEND:

COMFORT CATEGORIES:
1 - 7 mph
8 - 11 mph
> 11 mph

SENSOR LOCATION:
Grade Level

MITIGATION:
Existing Landscaping
Van Ness Corridor Transit Improvement Project Landscaping
Van Ness Corridor Transit Improvement Project Bus Shelter
Proposed Landscaping
Individual Project

0 150 300ft

Pedestrian Wind Comfort Conditions
Existing + Hub Plan EIR
Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 1b
Approx. Scale:	1"=300'
Date Revised:	Dec. 5, 2018

INDIVIDUAL PROJECT SITE BUILDINGS:
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15: 160 South Van Ness Avenue
16: 170 South Van Ness Avenue
17: 1695 Mission Street

CUMULATIVE BUILDINGS:
18. 1601 Mission Street
19. 1629 Market Street Colton Affordable
20. 1629 Market Street Building D
21. 1629 Market Street Building C
22. 1629 Market Street Building B
23. 1629 Market Street Building A
24. 1700 Market Street
25. 1704 Market Street
26. 188 Octavia Street
27. Parcel R.
28. Parcel S.
29. 300-350 Octavia Street
30. 300-350 Octavia Street
31. 200-214 Van Ness Avenue
32. Grove + Van Ness Avenue
33. 1270 Mission Street
34. 198 Valencia Street

HUB BOUNDARY
FELL STREET
HICKORY STREET
OAK STREET
MARKET STREET
TWELFTH STREET
MISSION STREET
ELEVENTH STREET
GOUGH STREET
OTIS STREET
SOUTH VAN NESS AVENUE

LEGEND:

COMFORT CATEGORIES:
1 - 7 mph
8 - 11 mph
> 11 mph

SENSOR LOCATION:
Grade Level

MITIGATION:
Existing Landscaping
Van Ness Corridor Transit Improvement Project Landscaping
Van Ness Corridor Transit Improvement Project Bus Shelter
Proposed Landscaping
Individual Project

0 150 300ft

Pedestrian Wind Comfort Conditions
Cumulative 1
Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 1c
Approx. Scale:	1"=300'
Date Revised:	Dec. 5, 2018

INDIVIDUAL PROJECT SITE BUILDINGS:
1: 30 Van Ness Avenue
2: 98 Franklin Street

HUB PLAN PROGRAMMATIC SITE BUILDINGS:
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HUB BOUNDARY
FELL STREET
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MARKET STREET
TWELFTH STREET
MISSION STREET
ELEVENTH STREET
GOUGH STREET
OTIS STREET
SOUTH VAN NESS AVENUE

LEGEND:

COMFORT CATEGORIES:
1 - 7 mph
8 - 11 mph
> 11 mph

SENSOR LOCATION:
Grade Level

MITIGATION:
Existing Landscaping
Van Ness Corridor Transit Improvement Project Landscaping
Van Ness Corridor Transit Improvement Project Bus Shelter
Proposed Landscaping
Individual Project

0 150 300ft

Pedestrian Wind Comfort Conditions
Cumulative 2
Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 1d
Approx. Scale:	1"=300'
Date Revised:	Dec. 5, 2018

HUB BOUNDARY

FELL STREET

HICKORY STREET

OAK STREET

MARKET STREET

TWELFTH STREET

MISSION STREET

ELEVENTH STREET

GOUGH STREET

OTIS STREET

SOUTH VAN NESS AVENUE

TWELFTH STREET

LEGEND:

HAZARD CATEGORIES:

Pass

Exceeded

SENSOR LOCATION:

Grade Level

MITIGATION:

Existing Landscaping

Van Ness Corridor Transit Improvement Project Landscaping

Van Ness Corridor Transit Improvement Project Bus Shelter

0 150 300ft

Pedestrian Wind Hazard Conditions

Existing

Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 2a
Approx. Scale:	1"=300'
Date Revised:	Dec. 5, 2018

INDIVIDUAL PROJECT SITE BUILDINGS:
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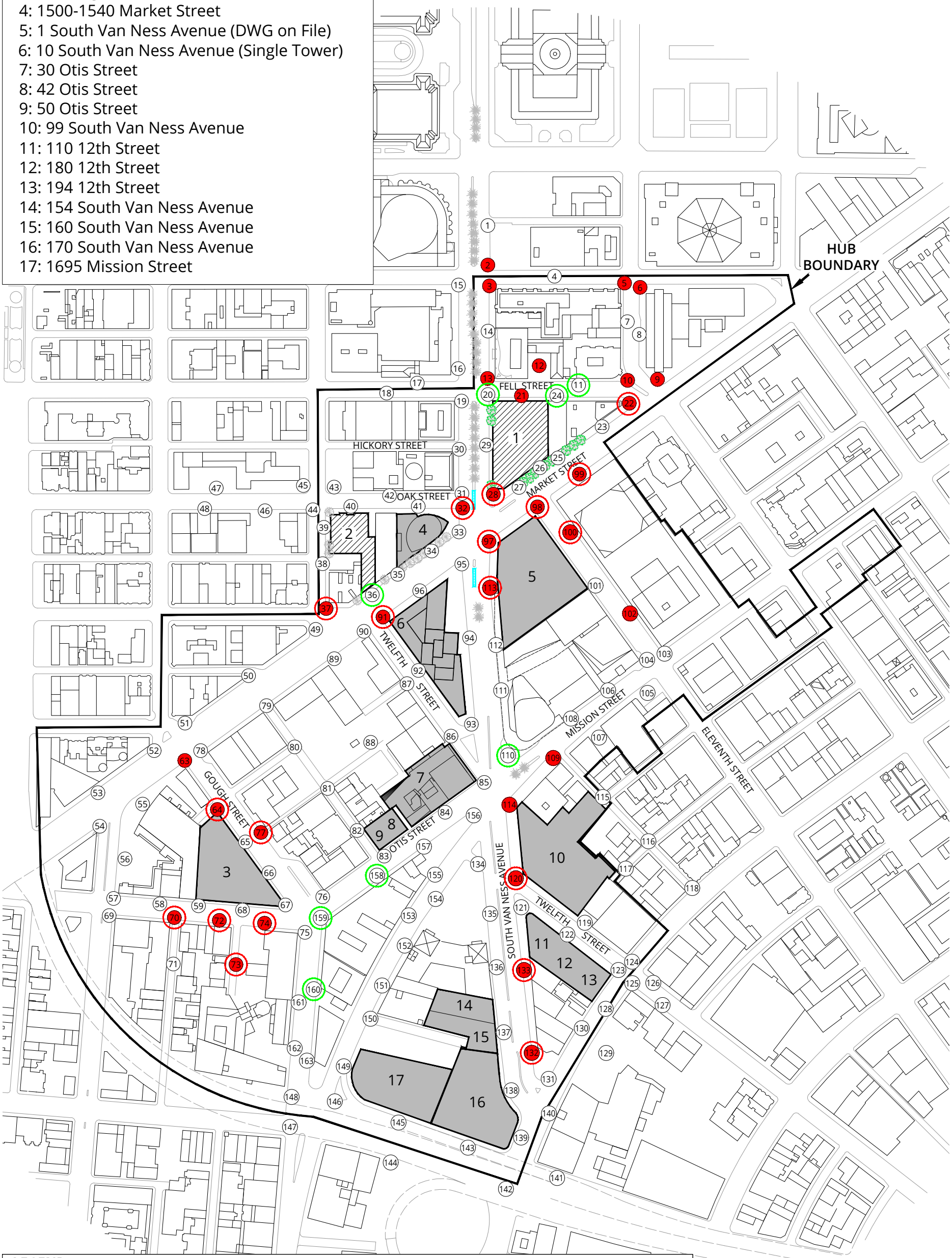
17: 1695 Mission Street



LEGEND:

HAZARD CATEGORIES:
Pass
Exceeded

SENSOR LOCATION:
Grade Level

MITIGATION:
Existing Landscaping
Van Ness Corridor Transit Improvement Project Landscaping
Van Ness Corridor Transit Improvement Project Bus Shelter
Proposed Landscaping
Individual Project
Addition of Hazard in Relation to Existing
Reduction of Hazard in Relation to Existing

0 150 300ft

Pedestrian Wind Hazard Conditions

Existing + Hub Plan EIR
Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 2b
Approx. Scale:	1"=300'
Date Revised:	Dec. 5, 2018

INDIVIDUAL PROJECT SITE BUILDINGS:
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HUB BOUNDARY
FELL STREET
HICKORY STREET
OAK STREET
MARKET STREET
TWELFTH STREET
MISSION STREET
ELEVENTH STREET
GOUGH STREET
OTIS STREET
SOUTH VAN NESS AVENUE

LEGEND:

HAZARD CATEGORIES:
Pass
Exceeded

SENSOR LOCATION:
Grade Level

MITIGATION:
Existing Landscaping
Van Ness Corridor Transit Improvement Project Landscaping
Van Ness Corridor Transit Improvement Project Bus Shelter
Proposed Landscaping
Individual Project
Addition of Hazard in Relation to Existing
Reduction of Hazard in Relation to Existing

0 150 300ft

Pedestrian Wind Hazard Conditions
Cumulative 1
Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 2c
Approx. Scale:	1"=300'
Date Revised:	Dec. 5, 2018

INDIVIDUAL PROJECT SITE BUILDINGS:
1: 30 Van Ness Avenue
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HUB BOUNDARY
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MISSION STREET
ELEVENTH STREET
GOUGH STREET
OTIS STREET
SOUTH VAN NESS AVENUE

LEGEND:

HAZARD CATEGORIES:
Pass
Exceeded

SENSOR LOCATION:
Grade Level

MITIGATION:
Existing Landscaping
Van Ness Corridor Transit Improvement Project Landscaping
Van Ness Corridor Transit Improvement Project Bus Shelter
Proposed Landscaping
Individual Project
Addition of Hazard in Relation to Existing
Reduction of Hazard in Relation to Existing

0 150 300ft

Pedestrian Wind Hazard Conditions
Cumulative 2
Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 2d
Approx. Scale:	1"=300'
Date Revised:	Dec. 5, 2018

LEGEND:

SENSOR LOCATION:
- Bicycle Lanes

MITIGATION:
- Existing Landscaping
- Van Ness Corridor Transit Improvement Project Landscaping
- Van Ness Corridor Transit Improvement Project Bus Shelter

Bike Route Sensors are for informational purposes only.

0 150 300ft

Bike Lane Test Locations

Existing
Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 3a
Approx. Scale:	1"=300'
Date Revised:	Jan. 3, 2019

INDIVIDUAL PROJECT SITE BUILDINGS:
1: 30 Van Ness Avenue
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TWELFTH STREET
MISSION STREET
ELEVENTH STREET
GOUGH STREET
OTIS STREET
SOUTH VAN NESS AVENUE
TWELFTH STREET

LEGEND:

SENSOR LOCATION:
- Bicycle Lanes

MITIGATION:
- Existing Landscaping
- Van Ness Corridor Transit Improvement Project Landscaping
- Van Ness Corridor Transit Improvement Project Bus Shelter
- Proposed Landscaping

Bike Route Sensors are for informational purposes only.

0 150 300ft

Bike Lane Test Locations
Existing + Hub Plan PIR
Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 3b
Approx. Scale:	1"=300'
Date Revised:	Jan. 3, 2019

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HUB BOUNDARY
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TWELFTH STREET
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GOUGH STREET
OTIS STREET
SOUTH VAN NESS AVENUE

LEGEND:

SENSOR LOCATION:
- Bicycle Lanes

MITIGATION:
- Existing Landscaping
- Van Ness Corridor Transit Improvement Project Landscaping
- Van Ness Corridor Transit Improvement Project Bus Shelter
- Proposed Landscaping

Bike Route Sensors are for informational purposes only.

0 150 300ft

Bike Lane Test Locations
Cumulative 1
Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 3c
Approx. Scale:	1"=300'
Date Revised:	Jan. 3, 2019

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HUB BOUNDARY
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MISSION STREET
ELEVENTH STREET
GOUGH STREET
OTIS STREET
SOUTH VAN NESS AVENUE

LEGEND:

SENSOR LOCATION:
Bicycle Lanes

MITIGATION:
Existing Landscaping
Van Ness Corridor Transit Improvement Project Landscaping
Van Ness Corridor Transit Improvement Project Bus Shelter
Proposed Landscaping

Bike Route Sensors are for informational purposes only.

0 150 300ft

Bike Lane Test Locations
Cumulative 2
Annual

Market/Octavia Hub Plan - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 3d
Approx. Scale:	1"=300'
Date Revised:	Jan. 3, 2019

TABLES

Table 1: Wind Comfort Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
1	15	25	e	18	41	3	e	21	47	6	e	21	47	6	e
2	22	49	e	23	52	1	e	20	47	-2	e	21	47	-1	e
3	23	50	e	25	54	2	e	24	55	1	e	25	54	2	e
4	17	35	e	18	40	1	e	17	37	0	e	18	39	1	e
5	20	43	e	19	41	-1	e	19	42	-1	e	20	43	0	e
6	18	35	e	17	32	-1	e	16	28	-2	e	16	29	-2	e
7	12	16	e	12	17	0	e	12	16	0	e	12	16	0	e
8	14	23	e	15	25	1	e	14	24	0	e	14	24	0	e
9	25	51	e	26	52	1	e	24	51	-1	e	25	52	0	e
10	22	51	e	22	51	0	e	21	50	-1	e	22	51	0	e
11	20	45	e	18	38	-2	e	17	36	-3	e	18	38	-2	e
12	23	49	e	21	48	-2	e	20	46	-3	e	21	47	-2	e
13	22	51	e	22	51	0	e	21	50	-1	e	21	50	-1	e
14	12	16	e	13	19	1	e	13	20	1	e	13	20	1	e
15	16	31	e	15	27	-1	e	15	27	-1	e	15	27	-1	e
16	15	26	e	13	20	-2	e	13	19	-2	e	13	19	-2	e
17	8	2		8	1	0		8	1	0		8	1	0	
18	9	6		9	4	0		9	4	0		9	3	0	
19	16	30	e	14	22	-2	e	14	22	-2	e	13	21	-3	e
20	20	47	e	17	36	-3	e	17	35	-3	e	17	34	-3	e
21	26	60	e	23	54	-3	e	23	54	-3	e	24	55	-2	e
22	16	29	e	19	39	3	e	18	35	2	e	19	37	3	e
23	12	14	e	12	12	0	e	11	10	-1		11	10	-1	
24	22	50	e	18	38	-4	e	18	40	-4	e	19	43	-3	e
25	10	5		15	24	5	e	14	23	4	e	15	24	5	e
26	10	5		13	19	3	e	13	20	3	e	13	21	3	e
27	9	4		15	24	6	e	14	23	5	e	15	26	6	e
28	14	25	e	24	54	10	e	24	55	10	e	25	54	11	e
29	13	16	e	13	19	0	e	14	22	1	e	14	22	1	e
30	14	19	e	17	36	3	e	18	38	4	e	17	35	3	e
31	11	10		14	20	3	e	13	19	2	e	13	19	2	e
32	14	24	e	18	35	4	e	18	35	4	e	18	36	4	e
33	11	10		15	23	4	e	14	22	3	e	15	23	4	e
34	18	37	e	18	38	0	e	20	43	2	e	19	39	1	e

Table 1a: Wind Comfort Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
35	10	7		13	19	3	e	13	19	3	e	10	7	0	
36	20	47	e	10	5	-10		10	7	-10		11	10	-9	
37	13	18	e	22	52	9	e	22	52	9	e	23	54	10	e
38	13	20	e	15	23	2	e	14	18	1	e	14	20	1	e
39	11	10		20	42	9	e	18	35	7	e	18	35	7	e
40	16	31	e	13	14	-3	e	12	14	-4	e	12	14	-4	e
41	17	33	e	15	23	-2	e	15	23	-2	e	14	22	-3	e
42	14	24	e	13	21	-1	e	13	21	-1	e	13	21	-1	e
43	14	20	e	15	28	1	e	16	28	2	e	15	27	1	e
44	9	4		17	37	8	e	17	38	8	e	17	36	8	e
45	9	2		13	18	4	e	13	19	4	e	13	17	4	e
46	10	5		11	10	1		11	10	1		11	10	1	
47	11	10		10	6	-1		10	5	-1		10	5	-1	
48	13	20	e	12	14	-1	e	11	10	-2		11	10	-2	
49	13	13	e	14	24	1	e	15	25	2	e	14	22	1	e
50	7	0		7	0	0		9	2	2		8	2	1	
51	13	16	e	12	15	-1	e	11	10	-2		11	10	-2	
52	10	6		10	6	0		10	8	0		11	10	1	
53	8	1		8	1	0		9	3	1		9	4	1	
54	14	20	e	13	17	-1	e	12	12	-2	e	12	12	-2	e
55	13	20	e	12	15	-1	e	13	19	0	e	13	19	0	e
56	14	23	e	14	23	0	e	14	24	0	e	15	27	1	e
57	14	18	e	13	16	-1	e	10	5	-4		10	7	-4	
58	14	22	e	18	39	4	e	16	29	2	e	19	41	5	e
59	11	10		16	29	5	e	26	59	15	e	18	36	7	e
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
63	22	48	e	20	46	-2	e	17	35	-5	e	18	40	-4	e
64	14	23	e	17	33	3	e	19	42	5	e	16	31	2	e
65	16	27	e	14	23	-2	e	14	23	-2	e	16	29	0	e
66	12	15	e	12	12	0	e	10	6	-2		12	12	0	e
67	13	20	e	15	26	2	e	11	10	-2		15	28	2	e
68	10	6		14	23	4	e	8	1	-2		14	22	4	e

Table 1a: Wind Comfort Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
69	15	29	e	16	29	1	e	14	22	-1	e	14	24	-1	e
70	17	32	e	20	46	3	e	18	39	1	e	19	43	2	e
71	6	0		12	13	6	e	14	23	8	e	14	18	8	e
72	14	23	e	24	53	10	e	20	45	6	e	24	53	10	e
73	16	28	e	20	44	4	e	19	41	3	e	20	43	4	e
74	16	32	e	19	41	3	e	20	42	4	e	20	43	4	e
75	15	24	e	13	16	-2	e	13	16	-2	e	13	16	-2	e
76	15	25	e	13	21	-2	e	13	18	-2	e	12	17	-3	e
77	16	30	e	21	48	5	e	21	48	5	e	22	49	6	e
78	14	23	e	15	24	1	e	13	18	-1	e	13	20	-1	e
79	16	32	e	15	27	-1	e	14	23	-2	e	14	23	-2	e
80	12	15	e	13	20	1	e	15	27	3	e	15	28	3	e
81	13	19	e	15	25	2	e	12	16	-1	e	13	18	0	e
82	16	30	e	16	30	0	e	14	22	-2	e	15	26	-1	e
83	15	25	e	18	38	3	e	16	29	1	e	17	34	2	e
84	10	7		10	7	0		11	10	1		12	14	2	e
85	13	20	e	16	29	3	e	13	20	0	e	13	21	0	e
86	12	13	e	14	21	2	e	13	19	1	e	13	17	1	e
87	12	14	e	13	17	1	e	13	19	1	e	13	18	1	e
88	12	15	e	10	6	-2		14	21	2	e	13	20	1	e
89	11	10		11	10	0		13	17	2	e	14	20	3	e
90	12	16	e	13	18	1	e	15	24	3	e	16	28	4	e
91	12	13	e	17	32	5	e	18	33	6	e	17	30	5	e
92	9	3		17	33	8	e	18	39	9	e	18	37	9	e
93	14	23	e	17	31	3	e	16	29	2	e	19	42	5	e
94	11	10		18	44	7	e	18	42	7	e	17	36	6	e
95	13	22	e	18	40	5	e	18	39	5	e	20	47	7	e
96	12	13	e	19	43	7	e	19	42	7	e	18	37	6	e
97	15	26	e	21	45	6	e	21	45	6	e	22	51	7	e
98	14	23	e	26	60	12	e	26	59	12	e	26	59	12	e
99	12	16	e	19	42	7	e	19	42	7	e	20	44	8	e
100	11	10		21	47	10	e	21	48	10	e	21	44	10	e
101	15	28	e	12	17	-3	e	12	15	-3	e	12	16	-3	e
102	21	49	e	17	34	-4	e	17	32	-4	e	17	32	-4	e

Table 1a: Wind Comfort Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
103	17	35	e	14	24	-3	e	14	22	-3	e	15	24	-2	e
104	17	34	e	14	23	-3	e	13	18	-4	e	14	23	-3	e
105	11	10		10	8	-1		10	8	-1		9	6	-2	
106	13	17	e	9	4	-4		9	4	-4		9	4	-4	
107	15	24	e	12	14	-3	e	12	14	-3	e	13	19	-2	e
108	17	31	e	8	1	-9		8	2	-9		11	10	-6	
109	25	57	e	21	47	-4	e	21	47	-4	e	21	49	-4	e
110	21	48	e	20	46	-1	e	20	44	-1	e	20	46	-1	e
111	13	18	e	9	2	-4		9	2	-4		13	15	0	e
112	13	18	e	15	29	2	e	15	30	2	e	15	26	2	e
113	11	10		17	35	6	e	17	34	6	e	18	40	7	e
114	19	39	e	20	45	1	e	19	43	0	e	20	46	1	e
115	15	24	e	17	36	2	e	18	37	3	e	18	39	3	e
116	14	20	e	9	4	-5		9	4	-5		10	4	-4	
117	11	10		8	1	-3		8	2	-3		9	2	-2	
118	14	21	e	9	3	-5		9	3	-5		9	2	-5	
119	14	23	e	18	35	4	e	16	31	2	e	17	33	3	e
120	17	36	e	21	48	4	e	21	48	4	e	22	49	5	e
121	15	26	e	17	37	2	e	20	39	5	e	19	39	4	e
122	12	18	e	17	33	5	e	15	25	3	e	16	30	4	e
123	11	10		14	23	3	e	13	16	2	e	13	19	2	e
124	15	23	e	19	37	4	e	18	35	3	e	19	38	4	e
125	13	20	e	14	23	1	e	13	20	0	e	14	22	1	e
126	11	10		15	24	4	e	14	22	3	e	15	26	4	e
127	11	10		9	2	-2		9	3	-2		10	5	-1	
128	11	10		15	24	4	e	16	26	5	e	16	26	5	e
129	12	18	e	16	29	4	e	14	22	2	e	14	23	2	e
130	7	0		10	5	3		8	2	1		9	3	2	
131	12	15	e	10	5	-2		8	1	-4		8	2	-4	
132	10	5		20	45	10	e	15	26	5	e	15	27	5	e
133	16	30	e	21	47	5	e	22	46	6	e	23	49	7	e
134	15	27	e	14	24	-1	e	25	53	10	e	26	56	11	e
135	12	13	e	13	21	1	e	16	29	4	e	16	30	4	e
136	8	1		14	23	6	e	15	26	7	e	16	28	8	e

Table 1a: Wind Comfort Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
137	6	0		10	5	4		10	8	4		11	10	5	
138	11	10		8	1	-3		8	1	-3		8	2	-3	
139	13	17	e	7	0	-6		7	0	-6		7	0	-6	
140	11	10		14	19	3	e	10	6	-1		10	8	-1	
141	12	13	e	10	5	-2		10	5	-2		10	5	-2	
142	10	6		8	1	-2		8	1	-2		8	1	-2	
143	11	10		10	4	-1		10	5	-1		10	5	-1	
144	9	2		9	3	0		9	5	0		9	4	0	
145	8	1		11	10	3		12	15	4	e	12	14	4	e
146	10	7		12	12	2	e	13	15	3	e	12	14	2	e
147	12	15	e	12	14	0	e	11	10	-1		11	10	-1	
148	11	10		11	10	0		10	6	-1		10	7	-1	
149	9	4		11	10	2		12	13	3	e	12	13	3	e
150	13	19	e	12	17	-1	e	13	20	0	e	13	19	0	e
151	15	25	e	14	20	-1	e	15	24	0	e	15	25	0	e
152	10	7		9	4	-1		17	32	7	e	17	29	7	e
153	14	23	e	13	16	-1	e	13	19	-1	e	13	18	-1	e
154	13	20	e	12	15	-1	e	14	22	1	e	14	22	1	e
155	12	15	e	13	17	1	e	17	35	5	e	17	35	5	e
156	12	13	e	18	36	6	e	18	37	6	e	18	38	6	e
157	16	28	e	15	27	-1	e	14	24	-2	e	15	26	-1	e
158	17	31	e	13	17	-4	e	11	10	-6		12	13	-5	e
159	17	32	e	14	23	-3	e	13	21	-4	e	13	19	-4	e
160	18	34	e	12	16	-6	e	12	14	-6	e	12	13	-6	e
161	13	19	e	10	7	-3		10	6	-3		10	6	-3	
162	11	10		9	5	-2		9	5	-2		9	5	-2	
163	13	15	e	10	6	-3		10	8	-3		11	10	-2	

Table 1a: Wind Comfort Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
SUMMARY	**Average (mph)**	**Average (%)**	**Total**	**Average (mph)**	**Average (%)**	**Speed Change (mph)**	**Total**	**Average (mph)**	**Average (%)**	**Speed Change (mph)**	**Total**	**Average (mph)**	**Average (%)**	**Speed Change (mph)**	**Total**
	14	**21**	**114 ---- 160**	**15**	**25**	**1**	**125 ---- 160**	**15**	**24**	**1**	**120 ---- 160**	**15**	**25**	**1**	**125 ---- 160**

Table 2: Wind Hazard Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
1	27	0		33	0	0		37	1	1	e	37	2	2	e
2	39	16	e	42	31	15	e	37	1	-15	e	38	3	-13	e
3	40	21	e	45	54	33	e	45	55	34	e	46	62	41	e
4	30	0		32	0	0		31	0	0		31	0	0	
5	42	20	e	40	9	-11	e	42	20	0	e	43	23	3	e
6	39	5	e	39	4	-1	e	37	2	-3	e	37	2	-3	e
7	22	0		22	0	0		23	0	0		22	0	0	
8	26	0		29	0	0		29	0	0		28	0	0	
9	42	49	e	47	81	32	e	49	86	37	e	50	105	56	e
10	43	23	e	41	15	-8	e	41	17	-6	e	42	21	-2	e
11	38	2	e	35	0	-2		34	0	-2		35	0	-2	
12	41	23	e	39	5	-18	e	38	3	-20	e	39	5	-18	e
13	44	26	e	41	15	-11	e	41	12	-14	e	41	13	-13	e
14	22	0		24	0	0		24	0	0		25	0	0	
15	29	0		29	0	0		29	0	0		29	0	0	
16	28	0		24	0	0		24	0	0		25	0	0	
17	16	0		15	0	0		15	0	0		15	0	0	
18	20	0		18	0	0		18	0	0		17	0	0	
19	30	0		24	0	0		23	0	0		23	0	0	
20	39	5	e	32	0	-5		31	0	-5		30	0	-5	
21	53	158	e	44	32	-126	e	44	29	-129	e	46	42	-116	e
22	35	0		42	17	17	e	41	16	16	e	44	26	26	e
23	25	0		23	0	0		24	0	0		25	0	0	
24	47	48	e	35	0	-48		36	1	-47	e	38	2	-46	e
25	19	0		26	0	0		26	0	0		27	0	0	
26	20	0		23	0	0		24	0	0		26	0	0	
27	19	0		27	0	0		25	0	0		26	0	0	
28	31	0		45	49	49	e	46	54	54	e	48	72	72	e
29	29	0		25	0	0		28	0	0		28	0	0	
30	30	0		30	0	0		30	0	0		29	0	0	
31	24	0		24	0	0		24	0	0		23	0	0	
32	27	0		37	2	2	e	38	3	3	e	38	2	2	e
33	20	0		29	0	0		28	0	0		31	0	0	
34	34	0		35	0	0		38	5	5	e	40	11	11	e

Table 2a: Wind Hazard Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
35	22	0		23	0	0		23	0	0		20	0	0	
36	36	1	e	18	0	-1		20	0	-1		24	0	-1	
37	31	0		46	40	40	e	45	33	33	e	47	52	52	e
38	25	0		30	0	0		30	0	0		31	0	0	
39	18	0		34	0	0		31	0	0		30	0	0	
40	29	0		25	0	0		26	0	0		25	0	0	
41	35	0		30	0	0		30	0	0		30	0	0	
42	25	0		26	0	0		26	0	0		25	0	0	
43	30	0		30	0	0		30	0	0		30	0	0	
44	16	0		32	0	0		32	0	0		32	0	0	
45	18	0		25	0	0		26	0	0		24	0	0	
46	18	0		24	0	0		23	0	0		23	0	0	
47	22	0		19	0	0		19	0	0		19	0	0	
48	28	0		24	0	0		21	0	0		23	0	0	
49	29	0		29	0	0		30	0	0		28	0	0	
50	14	0		13	0	0		16	0	0		16	0	0	
51	22	0		21	0	0		19	0	0		19	0	0	
52	20	0		19	0	0		20	0	0		22	0	0	
53	15	0		15	0	0		17	0	0		17	0	0	
54	28	0		29	0	0		24	0	0		23	0	0	
55	25	0		24	0	0		24	0	0		24	0	0	
56	28	0		27	0	0		26	0	0		27	0	0	
57	29	0		28	0	0		19	0	0		20	0	0	
58	27	0		35	0	0		29	0	0		35	0	0	
59	22	0		31	0	0		49	107	107	e	33	0	0	
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
63	43	22	e	39	4	-18	e	33	0	-22		37	2	-20	e
64	26	0		36	1	1	e	37	2	2	e	34	0	0	
65	26	0		28	0	0		30	0	0		32	0	0	
66	22	0		23	0	0		19	0	0		23	0	0	
67	25	0		25	0	0		22	0	0		27	0	0	
68	20	0		26	0	0		16	0	0		25	0	0	

Table 2a: Wind Hazard Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
69	30	0		34	0	0		26	0	0		27	0	0	
70	35	0		41	15	15	e	34	0	0		35	0	0	
71	12	0		25	0	0		30	0	0		31	0	0	
72	31	0		48	65	65	e	36	1	1	e	48	65	65	e
73	29	0		45	31	31	e	42	18	18	e	40	8	8	e
74	29	0		40	8	8	e	39	5	5	e	42	17	17	e
75	31	0		29	0	0		29	0	0		28	0	0	
76	28	0		25	0	0		23	0	0		24	0	0	
77	28	0		39	4	4	e	41	13	13	e	39	4	4	e
78	26	0		28	0	0		25	0	0		26	0	0	
79	29	0		30	0	0		30	0	0		30	0	0	
80	29	0		28	0	0		30	0	0		31	0	0	
81	26	0		28	0	0		22	0	0		23	0	0	
82	28	0		30	0	0		25	0	0		27	0	0	
83	29	0		34	0	0		31	0	0		33	0	0	
84	24	0		18	0	0		24	0	0		25	0	0	
85	27	0		30	0	0		25	0	0		25	0	0	
86	23	0		26	0	0		24	0	0		24	0	0	
87	21	0		25	0	0		25	0	0		25	0	0	
88	21	0		19	0	0		25	0	0		27	0	0	
89	21	0		24	0	0		28	0	0		29	0	0	
90	22	0		28	0	0		34	0	0		32	0	0	
91	20	0		37	1	1	e	38	2	2	e	37	2	2	e
92	17	0		34	0	0		36	1	1	e	37	1	1	e
93	29	0		29	0	0		28	0	0		36	1	1	e
94	23	0		32	0	0		31	0	0		29	0	0	
95	24	0		30	0	0		30	0	0		39	5	5	e
96	26	0		34	0	0		33	0	0		40	6	6	e
97	29	0		44	26	26	e	44	28	28	e	47	53	53	e
98	25	0		53	172	172	e	53	163	163	e	54	170	170	e
99	25	0		41	12	12	e	41	14	14	e	42	17	17	e
100	23	0		48	61	61	e	48	61	61	e	49	65	65	e
101	29	0		23	0	0		22	0	0		24	0	0	
102	38	3	e	39	3	0	e	38	2	-1	e	39	5	2	e

Table 2a: Wind Hazard Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
103	30	0		35	0	0		34	0	0		37	1	1	e
104	32	0		34	0	0		33	0	0		34	0	0	
105	24	0		23	0	0		24	0	0		21	0	0	
106	24	0		17	0	0		17	0	0		17	0	0	
107	25	0		22	0	0		21	0	0		24	0	0	
108	32	0		15	0	0		15	0	0		19	0	0	
109	50	92	e	36	1	-91	e	36	1	-91	e	39	5	-87	e
110	44	26	e	35	0	-26		34	0	-26		35	0	-26	
111	24	0		16	0	0		15	0	0		26	0	0	
112	26	0		29	0	0		29	0	0		27	0	0	
113	18	0		36	1	1	e	36	1	1	e	38	2	2	e
114	38	4	e	36	1	-3	e	35	0	-4		40	6	2	e
115	25	0		33	0	0		33	0	0		35	0	0	
116	24	0		17	0	0		17	0	0		17	0	0	
117	21	0		15	0	0		15	0	0		16	0	0	
118	27	0		20	0	0		18	0	0		19	0	0	
119	27	0		31	0	0		29	0	0		31	0	0	
120	31	0		40	9	9	e	39	5	5	e	41	14	14	e
121	28	0		32	0	0		36	2	2	e	35	0	0	
122	23	0		29	0	0		28	0	0		29	0	0	
123	21	0		26	0	0		22	0	0		23	0	0	
124	26	0		34	0	0		34	0	0		35	0	0	
125	27	0		25	0	0		24	0	0		27	0	0	
126	21	0		26	0	0		27	0	0		28	0	0	
127	21	0		16	0	0		16	0	0		17	0	0	
128	23	0		27	0	0		31	0	0		34	0	0	
129	22	0		29	0	0		27	0	0		27	0	0	
130	12	0		18	0	0		16	0	0		17	0	0	
131	22	0		19	0	0		14	0	0		16	0	0	
132	18	0		37	2	2	e	30	0	0		32	0	0	
133	34	0		40	9	9	e	40	7	7	e	43	35	35	e
134	30	0		26	0	0		51	116	116	e	55	192	192	e
135	25	0		24	0	0		29	0	0		30	0	0	
136	15	0		27	0	0		28	0	0		29	0	0	

Table 2a: Wind Hazard Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
137	12	0		18	0	0		18	0	0		19	0	0	
138	21	0		14	0	0		14	0	0		15	0	0	
139	24	0		12	0	0		12	0	0		13	0	0	
140	21	0		32	0	0		19	0	0		21	0	0	
141	23	0		18	0	0		18	0	0		18	0	0	
142	19	0		15	0	0		14	0	0		14	0	0	
143	23	0		20	0	0		20	0	0		19	0	0	
144	16	0		17	0	0		19	0	0		18	0	0	
145	13	0		21	0	0		22	0	0		22	0	0	
146	19	0		23	0	0		29	0	0		29	0	0	
147	21	0		20	0	0		19	0	0		20	0	0	
148	20	0		19	0	0		18	0	0		18	0	0	
149	18	0		22	0	0		26	0	0		26	0	0	
150	24	0		25	0	0		26	0	0		27	0	0	
151	32	0		30	0	0		31	0	0		32	0	0	
152	19	0		18	0	0		35	0	0		37	1	1	e
153	29	0		25	0	0		27	0	0		27	0	0	
154	24	0		24	0	0		28	0	0		29	0	0	
155	23	0		26	0	0		36	1	1	e	37	2	2	e
156	26	0		31	0	0		35	0	0		36	1	1	e
157	33	0		31	0	0		31	0	0		33	0	0	
158	41	17	e	27	0	-17		23	0	-17		25	0	-17	
159	36	1	e	27	0	-1		25	0	-1		26	0	-1	
160	39	5	e	26	0	-5		24	0	-5		23	0	-5	
161	24	0		20	0	0		19	0	0		19	0	0	
162	23	0		18	0	0		18	0	0		18	0	0	
163	30	0		22	0	0		20	0	0		20	0	0	

Table 2a: Wind Hazard Conditions

Location	Existing			Existing + Hub Plan EIR				Cumulative 1				Cumulative 2			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
SUMMARY	Average (mph)	Total Hours	Total	Average (mph)	Total Hours	Hours Change	Total	Average (mph)	Total Hours	Hours Change	Total	Average (mph)	Total Hours	Hours Change	Total
	27	567	21 ---- 160	29	780	213	32 ---- 160	29	888	321	36 ---- 160	30	1123	556	41 ---- 160

Table 3: Bike Lane Results

Location	Mean Wind Speed (mph)			
	Existing	Existing + Hub Plan EIR	Cumulative 1	Cumulative 2
164	5	5	5	5
165	9	9	9	9
166	6	6	5	5
167	7	6	7	7
168	5	6	7	7
169	5	7	7	7
170	9	10	10	10
171	8	10	10	10
172	9	8	8	8
173	12	12	11	11
174	8	8	8	8
175	10	10	10	10
176	6	6	6	6
177	11	9	9	9
178	6	5	5	5
179	12	8	8	9
180	7	7	8	9
181	7	7	7	7
Average	8	8	8	8

APPENDIX A

SAN FRANCISCO
PLANNING DEPARTMENT

MEMO

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DATE: August 7, 2018 – REVISED

TO: Erin Efner, ICF

FROM: Alana Callagy, Environmental Planning

RE: Wind Analysis Massing Assumptions in the EIR for the Hub Plan, 30 Van Ness Avenue Project, 98 Franklin Street Project, and Hub Housing Sustainability District

The intent of this memo is to identify the approach to wind analysis to support the Hub Plan and related actions environmental impact report (Hub Plan EIR). The Hub Plan EIR will evaluate the potential physical environmental impacts that may occur if the Hub Plan, the Hub Housing Sustainability District, and the individual development projects at 30 Van Ness Avenue and 98 Franklin Street are implemented.

Background

Through the Hub Plan the San Francisco Planning Department proposes to rezone portions of an approximately 84-acre area of San Francisco within the Downtown/Civic Center, South of Market (SoMa), Western Addition, and Mission neighborhoods.[1] The Hub Plan, which will be an amendment to the 2008 Market and Octavia Area Plan, is a comprehensive plan for the easternmost portions of the Market and Octavia Area Plan.

The Hub Plan

The Hub Plan proposes zoning changes to allow for additional height at the Market Street and Van Ness Avenue and Mission Street and South Van Ness Avenue intersections, with towers ranging from 250 to 650 feet. This proposed zoning would also allow increases in heights for select properties. In total 17 properties are proposed for this height incease or "upzoning." Table 1 lists the properties proposed for height increases in the Hub Plan.

[1] San Francisco Planning Department, Neighborhood Groups Map, http://sf-planning.org/neighborhood-groups-map, accessed January 8, 2018. This document (and all other documents cited in this report, unless otherwise noted) is available for review at the San Francisco Planning Department, 1650 Mission Street, Suite 400, as part of Case File No. 2015-000940ENV.

TABLE 1. PROPOSED CHANGES TO HEIGHT LIMITS IN THE HUB PLAN

Address	Current Height Limit	Proposed Height Limit
30 Van Ness Avenue	400	520
1500–1540 Market Street (One Oak)	400	450
98 Franklin Street[a, b]	85	360
1 South Van Ness Avenue	400	650
10 South Van Ness Avenue[c]	400	590
30 Otis Street	250	320
42 Otis Street	50	65
50 Otis Street	50	65
99 South Van Ness Avenue	120	250
33 Gough Street	85	250
110 12th Street	85	120
180 12th Street	85	120
194 12th Street	85	120
154 South Van Ness Avenue	85	120
160 South Van Ness Avenue	85	120
170 South Van Ness Avenue	85	120
1695 Mission Street	85	120

[a]The EIR will analyze a height limit of 360 feet for 98 Franklin Street, as proposed by the project sponsor, whereas the draft Hub Plan proposes a height limit of 320 feet at this location.

[b]98 Franklin also includes the parcels located at Assessor's Block 0836/Lots 008, 009, and 013

[c]10 South Van Ness also includes the parcel associated with 80 South Van Ness.

The 17 sites can be further divided into four groups based on the level of information known about potential developments. These groups are:

1. Projects identified for upzoning seeking individual project-level environmental clearance through the Hub Plan EIR (two sites):
    - 30 Van Ness Avenue
    - 98 Franklin Street
2. Projects with completed environmental review but for a project that would not maximize the upzoned height allotment proposed under the Hub Plan (two sites):

- 1500-1540 Market Street (One Oak)
- 42 Otis Street

3. Projects identified for upzoning currently undergoing their own environmental review but which may not maximize the height upzoing proposed in the Hub Plan (two sites):
    - 10 South Van Ness Avenue
    - 30 Otis Street
4. Projects identified for upzoning that have not filed a development application (11 sites):
    - 1 South Van Ness Avenue
    - 50 Otis Street
    - 99 South Van Ness Avenue
    - 33 Gough Street
    - 110 12th Street
    - 180 12th Street
    - 194 12th Street
    - 154 South Van Ness Avenue
    - 160 South Van Ness Avenue
    - 170 South Van Ness Avenue
    - 1695 Mission Street

Three of the four sites (1500-1540 Market, 30 Otis, and 42 Otis streets) which received or are in the process of receiving environmental clearance propose heights less than the maximum heights proposed by the Hub Plan. The fourth site, 10 South Van Ness Avenue, proposes and is completing enviornmental review for both a project and a project variant. The 10 South Van Ness Avenue project variant would be consistent with the maximum height proposed by the Hub Plan while the 10 South Van Ness Avenue project would not (see Approach to Analysis section below for more detail about the 10 South Van Ness Avenue project). The four sites and their proposed or approved heights versus the heights proposed under the Hub Plan are shown in Table 2.

TABLE 2 PROPOSED OR APPROVED HEIGHTS IN DEVELOPMENT APPLICATIONS

Address	Proposed/Approved height (feet)	Proposed under the Hub (feet)
Projects with completed environmental review		
1500-1540 Market Street (One Oak)	400	450
42 Otis Street	55	65
Projects undergoing their own environmental review		
10 South Van Ness Avenue	Project: 400 Project Variant: 590	590
30 Otis Street	250	320

Approach to Analysis

The Hub Plan EIR Project Wind Analysis

Projects Seeking Project-Level Environmental Clearance Under the Hub Plan EIR

For the two individual projects seeking project-level environmental clearance through the Hub Plan EIR (i.e., 30 Van Ness Avenue and 98 Franklin Street), the wind analysis shall model buildings based on the current plans on file for those projects.

Projects with Their Own Environmental Environmental Review (Completed or Undergoing)

The Hub Plan proposes upzoning for two projects for which environmental review has been completed but construction has not yet begun - 1500-1540 Mission Street and 42 Otis Street. Completion of environmental review indicates that construction of these projects is reasonably forseeable, but not guaranteed. As these projects are not yet under construction, there is the possibility that the project sponsors may allow entitlements to expire and seek to develop a project that reaches the maximum height evaluated in the Hub Plan EIR (in the case of 1500-1540 Market Street, this would mean 50 feet of additional height and for 42 Otis Street it would mean 10 feet of additional height).

In addition, environmental review independent of the Hub Plan EIR is currently underway for two projects - 10 South Van Ness Avenue and 30 Otis Street. The review underway for 10 South Van Ness Avenue evaluates a project with two 400-foot-tall towers and a variant with one 590-foot-tall tower. Either of those options could ultimately be selected as the project for 10 South Van Ness Avenue. In the case of 30 Otis Street, the environmental review currently underway evaluates the potential impacts of a 250-foot tower, rather than the 320-foot height maximum proposed in the Hub Plan. These two projects are considered reasonably foreseeable because they have submitted environmental evaluation applications with the planning department and environmental review is underway. However, it is possible that one or both of the projects will not receive project approval, or that the project sponsors could, at a future date, propose a project that reaches the maximum height evaluated in the Hub Plan EIR. For this reason, the department has determined that the most conservative approach to determine potential wind effects in the area is to evaluate a massing based on the proposed projects (per project applications), but to assume building heights extrapolated to the maximum height limits per the Hub Plan.

To summarize, for purposes of the Hub Plan EIR project wind test, the wind tunnel model will include the following massings: a 450-foot single tower massing for 1500-1540 Market Street project; a 65-foot-tall building massing for the 42 Otis Street project; one 590-foot-tall tower variant for the 10 South Van Ness Avenue project; and a 320-foot-tall tower massing for 30 Otis Street project. For these four projects, the wind analysis will use plans on file with the department but the building models will be shaped in a more general or rounded form (e.g., a "wedding cake" look) and extrapolated to the maxium height proposed by the Hub Plan. This would result in massings similar in bulk and footprint as currently proposed but would also consider impacts of the maximum height proposed under the Hub Plan.

Projects with No Filed Development Applications

All Properties Except 1 South Van Ness Avenue

Ten of the 11 sites identified for upzoning in the Hub Plan and for which the department does not have environmental evaluation applications will be evaluated using the "boxy" massing approach (i.e., using the full site boundary extrapolated to the maximum height limit). This approach is considered the most

conservative shaping to determine potential wind effects of the Hub Plan EIR. The "boxy" massing approach would be used for the following sites:

- 50 Otis Street
- 99 South Van Ness Avenue
- 33 Gough Street
- 110 12th Street
- 180 12th Street
- 194 12th Street
- 154 South Van Ness Avenue
- 160 South Van Ness Avenue
- 170 South Van Ness Avenue
- 1695 Mission Street

1 South Van Ness Avenue

The Hub Plan proposes upzoning of the property at 1 South Van Ness Avenue to 650 feet. This site is approximately 1.5 acres, southeast of the intersection of Market Street and Van Ness Avenue, and represents the greatest maximum height of all Hub Plan sites. Based on the adjacent approximately 415- and 260-foot towers under construction at 1500 Mission Street and 49 South Van Ness Avenue, respectively; San Francisco Planning code requirements for tower separation; and the propose upzoning of 1 South Van Ness Avenue to 650 feet, it would be unreasonable to assume that a project with a maximum bulk will be constructed at this site. Therefore the planning department has prepared a massing design to best reflect the potential massing of a future project at 1 South Van Ness Avenue with a maximum height allowed by the proposed Hub Plan and massing and tower articluation consistent with San Francisco Planning code. This proposed massing sketch is attached to this memo (Attachment A).

Table 3 summarizes the department's proposed massing scenario for Hub Plan EIR project wind tunnel analysis.

TABLE 3: THE HUB PLAN EIR PROJECT WIND ANALYSIS

Project type	Massing for Project Analysis			
	Plans on file with Planning Department	*Plans on file with Planning Department but extrapolated to the maximum Hub Plan height*	*Maximum footprint and height (i.e., "boxy")*	*Planning Department Massing Sketch*
Individual project-level environmental clearance sought in the Hub Plan EIR	X			
Completed environmental review		X		
Undergoing their own environmental review*		X		
Plan parcels to be upzoned with no development application (excluding 1 South Van Ness Avenue)			X	
1 South Van Ness				X

*Note: assumes using the 10 South Van Ness Avenue Variant (i.e., the 590 foot single tower) with a rounded form.

The Hub Plan EIR Cumulative Wind Analysis

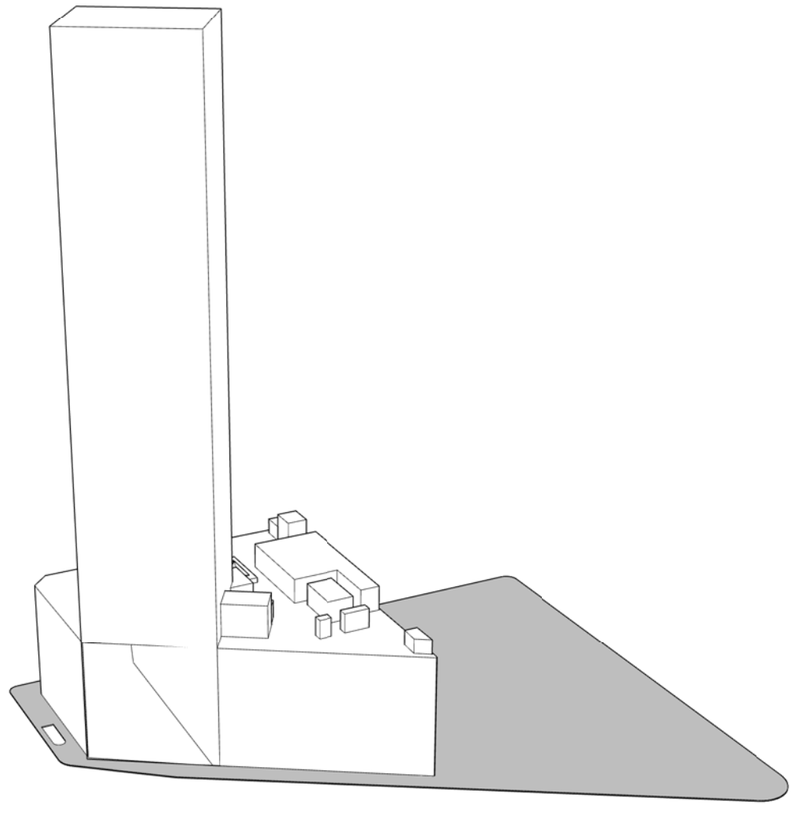
The San Francisco Planning Department Environmental Planning Division's standard protocol for cumulative wind analysis is to use plans on file with the department for projects for which an environmental evaluation application has been filed or which the department has otherwise determined reasonably foreseeable. Although four of the 17 sites proposed for upzoning by the Hub Plan have completed or are in the process of completing independent environmental review, the Hub Plan EIR comulative wind analysis will use the Hub Plan EIR project wind analysis assumptions for all 17 sites, because the EIR objective is to evaluate the potential effects of the Hub Plan EIR project combined with cumulatively forseeable projects.

However, as previously mentioned, the 10 South Van Ness Avenue project includes both a project and a variant. The variant, a single 590-foot tower, is

considered consistent with the proposed Hub Plan and shall, therefore, be used as the basis for the Hub Plan cumulative wind analysis. The 10 South Van Ness Avenue project (i.e., two 400-foot towers) is considered to be reasonably forseeable but with a different massing than the variant. Therefore, two cumulative scenarios will be analyzed (i.e., two separate cumulative wind model runs will be conducted) to capture both possible options at 10 South Van Ness Avenue (one tower or two towers). The two scenarios for cumulative analysis would allow for a greater understanding of potential cumulative wind impacts.

In addition, the consultant will be required to use the list of cumulative projects prepared by the department if those projects are within the wind tunnel geographic analysis area. This list of projects is attached to this memo (Attachment B).

Attachment A



Attachment B

Cumulative Project List for The Market Street Hub Area Plan Environmental Impact Report (EIR) 2015-000940ENV

	Address	Case File / Record No.	Height (feet)	Project Description
1	1629 Market Street (1601 – 1637 Market Street & 1125 Stevenson Street; 53 Colton Street (Plumbers Union site)) two parcels: 3505/008 and 032	2015-005848ENV	85 (can be up to 16 feet above roofline)	The proposed project would demolish the existing UA Local 38 building (1621 Market Street), demolish the majority of the Lesser Brothers Building (1629–1645 Market Street), rehabilitate the Civic Center Hotel (1601 Market Street), and demolish the 242-space surface parking lots. In total, construct five new buildings (ranging from four to 10 stories, 58 to 85-feet-tall). The project would include 477 market-rate residential units, 107 affordable supportive housing units. The project would also include the construction of 18,300-square-foot Brady Open Space at the northeast corner of Brady and Colton Streets. Within the new buildings there would be approximately 13,100 square feet of ground-floor retail/restaurant space.
2	1700 Market Street	2013.1179E	85 feet (approximately 100 feet tall with mechanical penthouse)	The project would demolish the existing two-story building on the site and construct an 8-story mixed-use residential building (up to 48 dwelling units) with approximately 1,500 square feet of ground floor retail.
3	1740 Market Street	2014.0409E	85 (+ up to 16 feet for mechanical features = 101 feet)	The project would demolish the existing approximately 25,000 square foot commercial building and construct a 9-story, 85-foot-tall mixed-use building with 110 group housing dwelling units, and approximately 7,600 square feet of ground-floor retail.
4	1601 Mission Street (Tower Car Wash)	2014.1121ENV	140 feet (includes mechanical penthouse and solarium)	The project would demolish the existing gas station facilities and construct a 120-foot-tall, 12-story mixed-use building containing up to 220 dwelling units; 7,336 square feet of retail space; up to 97 below-grade vehicle parking spaces that would be accessed from South Van Ness Avenue. The project is to include an additional 20 feet in height for a mechanical penthouse and solarium.
5	200-214 Van Ness Avenue	2015-012994ENV	120 (plus 15 feet rooftop = total 135 feet)	The proposed project would demolish two buildings a three-story building with 27 dwelling units (200 Van Ness Avenue) and a two-story, approximately 12,400 gross square feet (gsf) building with vacant office space previously occupied by the Lighthouse for the Blind (214 Van Ness Avenue); merge the two parcels; and construct a 12-story mixed-use building to provide housing and other facilities for the San Francisco Conservatory of Music. The proposed building would have approximately 113 units (420 beds), three faculty housing units, 27 housing units to replace the 27 existing units at 200 Van Ness Avenue, approximately 49,600 gsf of institutional uses, approximately 4,320 gsf of broadcasting studio space, and 5,000 gsf of restaurant space. The new building would be 120 feet tall, with an additional 12 feet to the top of rooftop architectural features ("upper roof") and another 2.5 feet to the top of roof-top mechanical equipment (total height of 134.5 feet). The project proposes two underground levels for bicycle storage, institutional spaces, and mechanical equipment. No vehicle parking would be provided.

6	Parcel M (300 Octavia Street) (APN 0832/026) & Parcel N (350 Octavia Street) (APN 0832/025)	2014-002330ENV	70 feet (includes elevator penthouse)	The project site consists of two discontinuous vacant lots located along the east side of Octavia Street between Fell and Oak streets. Parcel M is approximately 2,200-squarefoot lot with frontages on Fell, Octavia, and Hickory streets while Parcel N is approximately 2,300-square-foot lot with frontages on Oak, Octavia, and Hickory streets. The proposed project would involve the construction of two 55-foot-tall (70 feet with elevator penthouse), five-story, mixed-use buildings approximately 15,400 square feet in size with 12 residential units over approximately 800 square feet of ground-floor commercial use. No off-street parking is proposed. The proposed project includes the installation of a corner bulb-out at the southeast corner of Octavia and Fell streets.
7	Parcel T / 188 Octavia Street (APN 0853/033, 034, and 022)	2014.1509ENV	71 feet (includes elevator penthouse)	The project would construct a new 5-story, 55-foot-tall (71 feet with elevator penthouse) mixed-use building with up to 26 dwelling units above ground-floor commercial space. The project would not include off-street parking spaces.
8	Better Market Street (BMS)	2014.0012E	NA	San Francisco Public Works, in coordination with the San Francisco Planning Department and the SFMTA would redesign and provide various transportation and streetscape improvements to the 2.2-mile segment of Market Street between Octavia Boulevard and The Embarcadero.
9	Parcel O (455 Fell Street) (APN 0831/024)	2015-002837ENV	60 feet (includes elevator penthouse)	The 100% affordable housing project with approximately 108 below-market-rate apartment dwelling units, approximately 1,200 square feet of ground-floor retail space, approximately 2,000 square feet of office space, approximately 2,900 square feet of community activities space, and no vehicle parking. Build a mid-block pedestrian passage to connect Oak and Fell streets, and would align with a similar mid-block pedestrian passage that would be constructed as part of the Parcel P project.
10	Parcel R and Parcel S (APN 0838/034, 035, 093- 096)	2014.1322ENV	55 (does not include elevator penthouse estimate as no plans are available)	The project would redevelop each existing vacant lot into a mixed-use project consisting of two buildings with 100% affordable housing (up to 56 dwelling units) and approximately 7,500 square feet in each building of ground-floor neighborhood-serving retail. The project would partially satisfy the offsite Below Market Rate requirement for the multifamily One Oak Street residential project.
11	1245 Folsom (3756/041)	2015-014148ENV	79 and 60 feet (includes elevator penthouse)	Demolition of existing 1 story of Alt School and New Construction of a 7 story at Folsom street and 5 story at Ringold Street mixed-use building. 37 residential units above one 2 story commercial space at aground floor with parking space at basement level.

12	1228 Folsom	2014.0964ENV	79 feet tall (includes elevator penthouse)	Merge three lots into one lot, demolition of the existing 16,450 sf building, and the construction of a new 41,440-square-foot, mixed-use building containing 24 residential units and 1,110 square feet of groundfloor commercial use. The building would be 65 feet tall (79 feet tall with elevator penthouse) and six stories on its Folsom Street frontage and 45 feet tall and four stories on its Clementina Street frontage.
13	1695 Folsom	2015-012878ENV	no plans available	Erect 5 stories, 1 basement, 4 dwelling units
14	1500-1528 15th Street	2016-011827ENV	102 feet tall (includes elevator)	Demolish existing automotive salesoffice and smog check facility and parking area to construct an eight story, 62,100 gsf building with 1,300 sf of groundfloor retail and 184 group housing units. No off-street parking is proposed.
15	198 Valencia St (3502/108)	2013.1458E	71 feet tall (includes elevator penthouse)	Demolish existing one-story, 1,900 square foot oil change facility and a surface parking lot with seven off-street parking spaces and construct a five-story, 55 foot-tall, 33,795 gross square foot mixed-use building (6,269 gross square feet of ground-floor commercial space and a subterranean garage to accommodate 19 off-street parking spaceson, with 28 residential units (16 one-bedroom units and 12 two-bedroom units) on the first through fourth-floor levels.
16	1870 Market ST	2014.1060ENV	101 feet tall (includes elevator penthouse)	Demolish a vacant single-story, 600-gross-square-foot (gsf) commercial building and a four-vehicle surface parking lot and construct an approximately eight-story, 85-foot-tall (with an additional 16 feet for the mechanical and staircase penthouses) mixed-use development. The approximately 16,300-gsf building would be comprised of approximately 12,900 gsf of residential space and 400 gsf of ground-floor commercial space. The proposed project would provide approximately 10 dwelling units. No off-street parking is proposed.

APPENDIX B

98 Franklin Street
San Francisco, CA

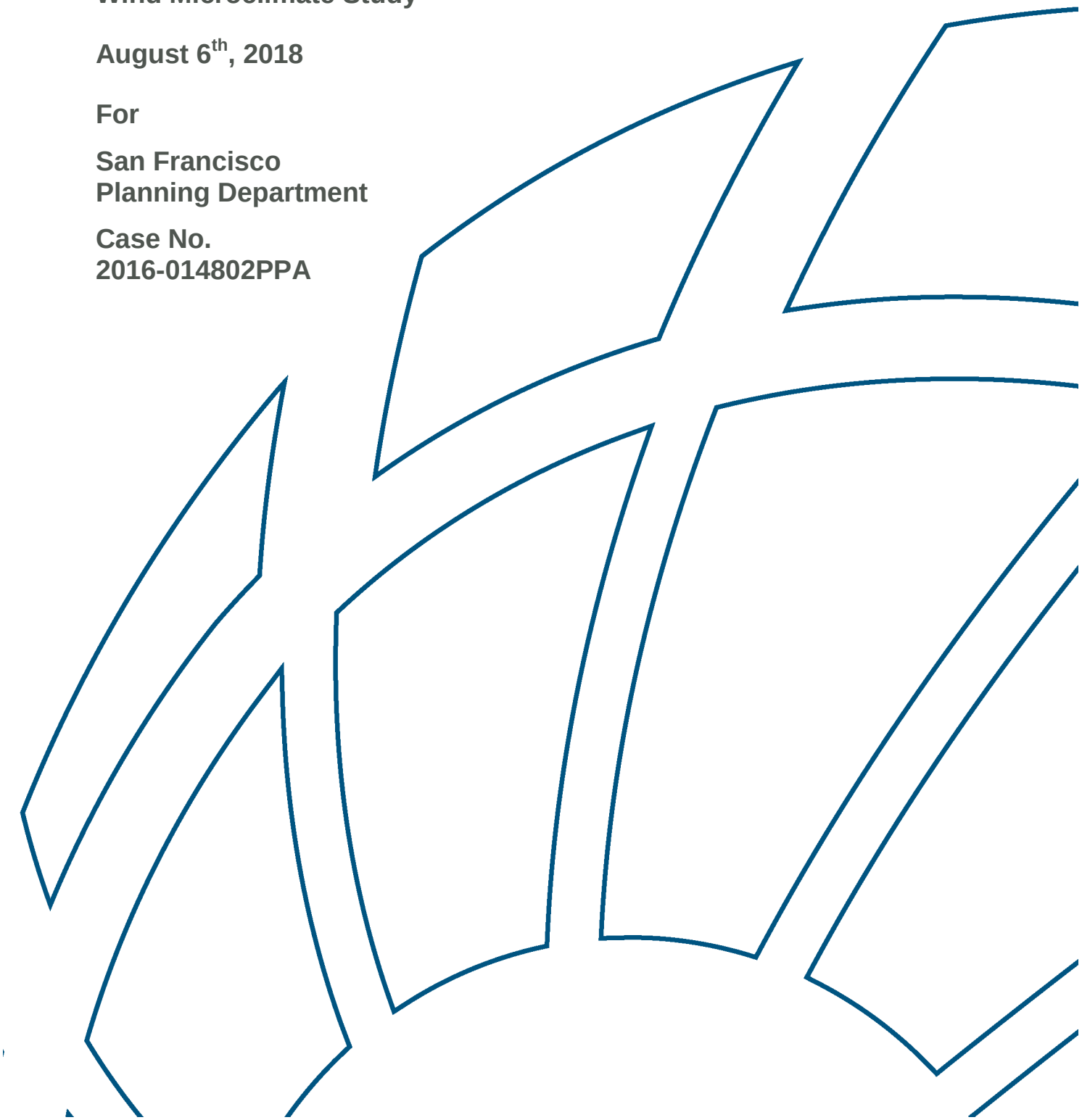
Wind Microclimate Study

August 6th, 2018

For

San Francisco
Planning Department

Case No.
2016-014802PPA



Report Title	**98 Franklin Street San Francisco, CA Wind Microclimate Study**	
For	**San Francisco Planning Department**	
Document No:	**432357rep1v3**	**Release: 3**
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	Name	Signature	Date
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Issue	Date	Description
1	**July 24th, 2018**	**First Issue**
2	**July 27th, 2018**	**Second Issue**
3	**August 6th, 2018**	**Third Issue**

98 Franklin Street
San Francisco, CA
Wind Microclimate Study

EXECUTIVE SUMMARY

Background

BMT has conducted a pedestrian-level wind study for the proposed 98 Franklin Street (hereafter "Proposed Project") located at the junction of Oak Street and Franklin Street and is in zoning district C-3-G, San Francisco, California. The purpose of the wind study is to assess the probability of the Proposed Project to cause local wind speeds to exceed "comfort" and "hazard" criteria at publicly accessible points in the project vicinity, in accordance with Section 148 of the San Francisco Planning Code.

Test Criteria

The following significance criteria are from Appendix B of the San Francisco Planning Environmental Review Guidelines and are used to determine the level of impacts related to wind. The Proposed Project would result in a significant impact if it would alter wind in a manner that substantially affects public areas.

Planning Code Section 148 establishes two wind comfort criteria that require, upon introduction of the Proposed Project, that equivalent wind speeds do not exceed 11 mile-per-hour (mph) more than 10% of the time between 7:00am and 6:00pm throughout the year, in areas of substantial pedestrian use, and seven mph in public seating areas.

Section 148 also establishes a wind hazard criterion that requires, upon introduction of new buildings or additions to existing buildings, that ground-level equivalent wind speeds do not exceed 26 mph for more than a single hour during the year.

Test Scenarios

The evaluation of wind comfort and hazards was carried out by testing a 1:300 scale model of the Proposed Project in a boundary layer wind tunnel in accordance with standard City of San Francisco test protocols. A total of 85 City-approved publicly-accessible ground-level locations ("test points") have been selected on project-area sidewalks and sidewalks corners within a 1,500-foot radius of the project vicinity in order to measure and then compare wind conditions for the following test scenarios:

- **Existing Scenario**: the existing condition, including buildings currently under construction, which serves as the baseline wind conditions in the study area
- **Existing Plus Project Scenario**: adding the proposed project to the existing conditions
- **Existing Plus Project with Mitigation Scenario**: adding wind mitigation measures to the project

Summary Results

The boundary layer wind tunnel study has assessed the wind microclimate in the 98 Franklin Street study area. On the basis of the wind tunnel modelling, the following conclusions have been drawn:

- Within the Existing Scenario, wind conditions exceed the comfort criterion at 64 out of 85 test points, with a combined average hourly wind speed of 14.2 mph. Under the Existing Scenario, wind conditions exceed the hazard criterion at 17 out of 85 test points, which collectively exceed the hazard criterion for a duration of 457 hours annually.

- Within the Existing Plus Project Scenario, wind conditions would exceed the comfort criterion at 71 out of 85 test points, which would represent a net increment of 7 test points compared to Existing Scenario. The average wind speed over all the test points would be increased from 14.2 mph in the Existing Scenario to 15.1 mph in the Existing Plus Project Scenario. The number of test points in which wind conditions exceed the hazard criterion would be increased from 17 in the Existing Scenario to 21 in the Existing Plus Project Scenario. Additionally, the total duration of hazardous wind conditions would be increased from 457 hours to 522 hours, representing a net increment of 65 hours of hazardous wind conditions compared to the Existing Scenario.

- Within the Existing Plus Project with Mitigation Scenario, wind conditions would exceed the comfort criterion at 69 out of 85 test points, which would represent a net decrement of 2 test points compared to the Existing Plus Project Scenario. The number of test points in which wind conditions exceed the hazard criterion would be decreased from 17 in the Existing Scenario to 14 in the Existing Plus Project with Mitigation Scenario. The total duration of hazardous wind conditions would be decreased from 457 hours to 427 hours, representing a net decrement of 30 hours of hazardous wind conditions compared to the Existing Scenario.

98 Franklin Street
San Francisco, CA
Wind Microclimate Study

1. Introduction

BMT has worked with the Related to conduct a pedestrian wind microclimate study for the proposed 98 Franklin Street (hereafter "Proposed Project") in San Francisco, California.

The purpose of the wind study is to assess the probability of whether the project would result in local wind speeds that would exceed "comfort" and "hazard" thresholds specified in San Francisco Planning Code Section 148 at publicly accessible points in the project vicinity in order to determine whether wind effects are suitable for the pedestrian environment.

1.1. Study Area

1.1.1. Project Site

The 23,753-square-foot project site is located on the block bounded by Market Street to the south, Franklin Street to the west, Oak Street to the north, and Van Ness Avenue to the east in the Civic/Downtown neighborhood, and within the C-3-G District and Van Ness and Market Downtown Residential Special Use District.

The site location is presented within the context of the wider surrounding area in **Figure 1.1**.

1.1.2. Project Description

The proposed project would remove the existing parking lot and construct a 380-foot-tall, mixed use building approximately 469,100 square feet in size.

1.2. Test Scenarios

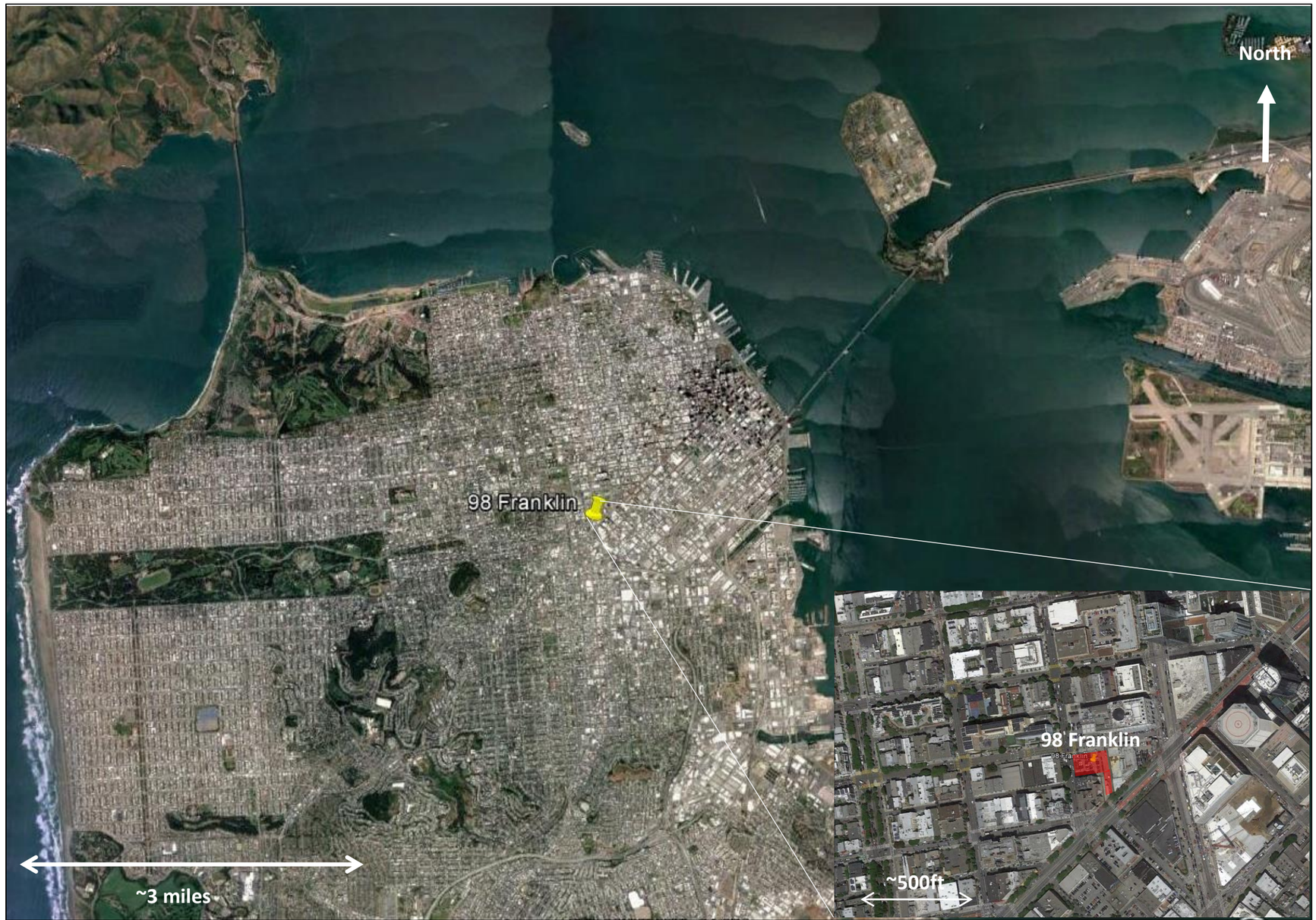
The study considers the following scenarios:

- **Existing Scenario:** the existing condition, including buildings currently under construction which serves as the baseline wind conditions in the study area
- **Existing Plus Project Scenario:** adding the Proposed Project to the existing conditions
- **Existing Plus Project with Mitigation Scenario:** adding wind mitigation measures to the project

The Existing Scenario is tested in order to characterize the wind environment on the project site and in the study area as it exists today without the Proposed Project. The Existing Plus Project Scenario entails testing a 1:300 scale model of the Proposed Project within the existing setting, in order to investigate changes to ground-level winds that the Proposed Project could affect. The Existing Plus Project with Mitigation Scenario added non-deciduous Project trees along Franklin Street and along Oak Street, replaced of four trees at the north side along Oak Street with non-deciduous trees, and an implementation of a canopy (option 6B) along the northern façade of the proposed Project to examine the changes to ground-level wind speeds could have. The Project trees are shown in **Figure 1.2**.

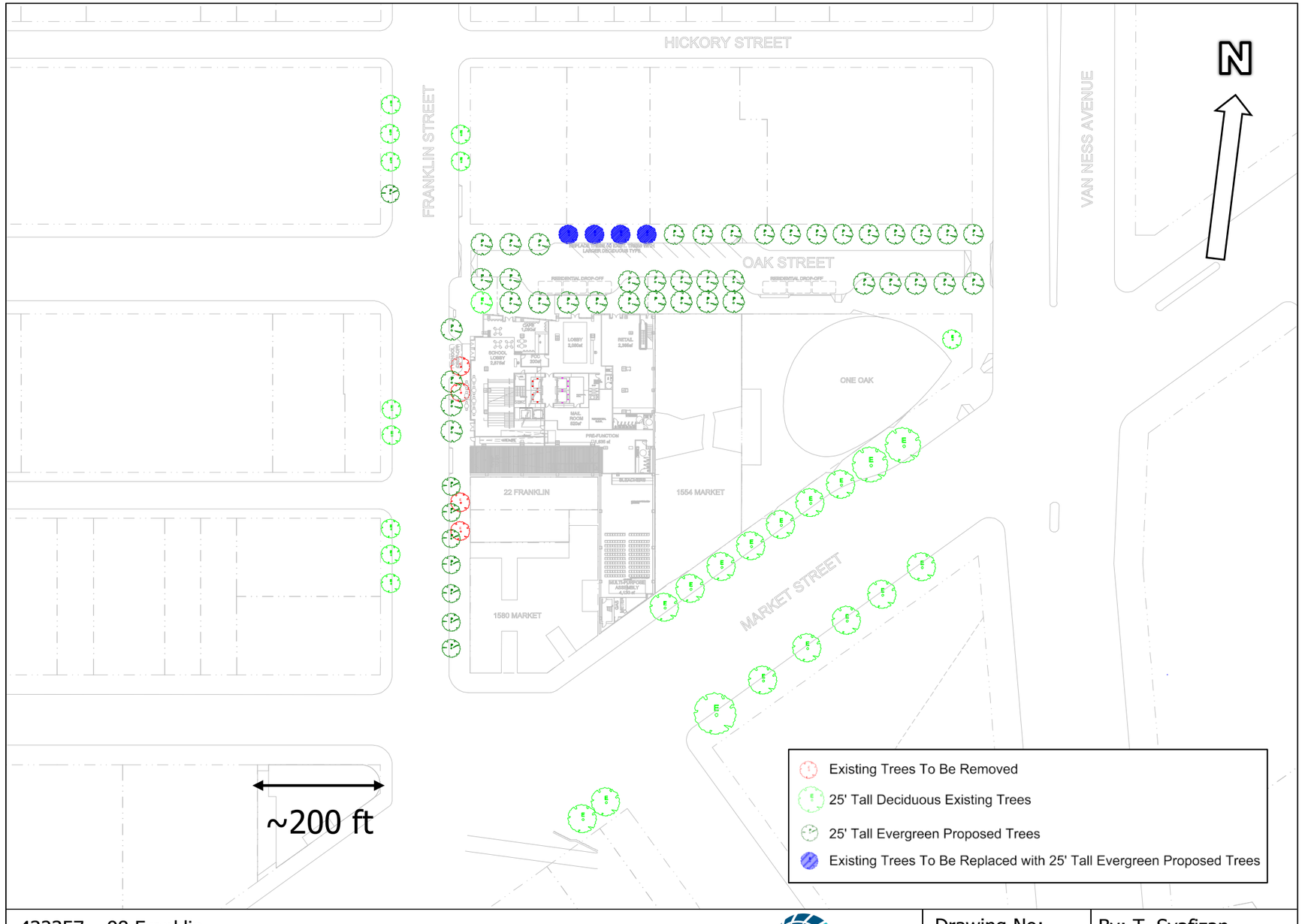
Figures 1.3 and **1.4** show the Existing Scenario, Existing Plus Project Scenario, respectively. Additionally, Appendix C contains photographs of the wind tunnel models of each scenario.

Figure 1.1: Site Location



432357 – 98 Franklin Aerial View of Development	BMT	Drawing No: 432357/FIG -1.1	By: T. Syafizan Date: July 16th, 2018

Figure 1.2: The Tree Plan



432357 – 98 Franklin Trees Plan	BMT	Drawing No: 432357/FIG -1.2	By: T. Syafizan Date: July 27th, 2018

Figure 1.3: Existing Scenario

432357 – 98 Franklin Existing Scenario	BMT	Drawing No: 432357/FIG -1.3	By: T. Syafizan Date: July 27th, 2018

Figure 1.4: Existing Plus Project Scenario

432357 – 98 Franklin Existing Plus Project Scenario	BMT	Drawing No: 432357/FIG -1.4	By: T. Syafizan Date: July 27th, 2018

2. The Assessment of Wind Microclimate

A microclimate can be defined as the distinctive climate of a small-scale area. The weather variables in a microclimate, such as wind, may be different to the conditions prevailing over the area as a whole.

Wind microclimate assessments consider the wind conditions that would result upon the introduction of a new development into an established setting. Wind speed data generated by tunnel testing assists decision-makers to determine whether a project's wind conditions would be suitable or unsuitable, and whether or not design adjustments or wind reduction measures would be required to address potentially hazardous wind effects or any pedestrian comfort issues. It is for these purposes, that wind microclimate assessments are undertaken.

2.1. Buildings, the Built Environment and Wind Speed

The direction and speed of wind currents can be altered by natural features of the land or by buildings and structures. A number of basic features can influence the wind flows around buildings. These include the general building envelope, the cross-sectional shape, the building orientation (particularly in relation to the prevailing wind direction), the overall height and proximity to other buildings and the general exposure of the site. Groups of buildings clustered together tend to act as obstacles that reduce wind speeds; the heights, massing, and orientations or profiles of the buildings are some of the factors that can affect wind speeds. When a building is much taller than those around it, rather than a similar height, it can intercept and redirect winds downward that might otherwise flow overhead. The winds can be directed down the vertical face of the building to ground level, and these redirected winds can be relatively strong and relatively turbulent. The massing of a building can affect wind speeds. In general, slab-shaped buildings have the greatest potential to accelerate ground-level winds, while buildings that have unusual shapes or are more geometrically complex tend to deflect the wind away from reaching to the pedestrian level.

The building height relative to the adjacent buildings is particularly important since higher level winds can be deflected by the building towards ground level. In general terms, for a given cross-sectional shape the higher the building, the windier it would be at ground level. Because of this downward deflection of high-level winds, significant localized acceleration can occur around the base of a building, particularly near the corners of the building. This is demonstrated by the common experience of windy conditions near tall buildings even on a relatively calm day.

The corner geometry in particular is important because sharp edged corners cause separated flows with strong wind speed gradients (rapid changes over a short distance). Softer, or more rounded corners improve this, although some acceleration still occurs.

The proximity of adjacent buildings is an important consideration with regard to wind shielding and funneling (channeling). The potential for local wind accelerations and decelerations due to interaction with local structures must be taken into account when assessing the local wind environment. Therefore, the adjacent relevant existing buildings have been incorporated into the wind model with more detail in regards to existing shape, massing, and architectural features.

3. The San Francisco Wind Climate

Between 1945 and 1950, data describing the speed, direction and frequency of occurrence of winds within the San Francisco area were recorded at the old San Francisco Federal Building at 50 United Nations Plaza.

Analysis of the wind data shows that average wind speeds in San Francisco are greater during summer and lower during winter. Strongest winds, however, tend to prevail during winter. Of the 16 primary wind directions, 4 have the greatest frequency of occurrence and these comprise the strongest and most commonly occurring winds. These are winds blowing from northwest, west-northwest, west, and west-southwest. However, boundary layer wind tunnel testing was conducted for all wind directions in increments of 22.5° for a total of 16 wind directions.

Ground roughness is an important factor in the development of the wind velocity close to the ground, as a rougher surface will slow the wind close to the ground. The topographic roughness varies throughout the City and surrounding region, with the smoothest in the region being the Pacific Ocean and the attached inland bays. Although the smoothness of the water varies with wave height, it can generally be assumed that the velocity of wind coming off the ocean is relatively high even at low elevations.

For the wind blowing from a quadrant centered on the west, the study area sits on the downwind edge of the San Francisco peninsula. While this is true, the upwind terrain, topography and building morphology do relatively little to impede strong prevailing winds originating from the Pacific. The buildings west of Franklin Street are typically relatively short – less than 80 feet tall – and therefore do little to intercept the most common winds from the northwest, west-northwest, west, and west-southwest. Thus, strong winds blow across the peninsula and reach the study area, which, in its immediate vicinity, is exposed to the west.

4. Assessment Criteria

4.1. Pedestrian Comfort and Hazard Wind Speeds

At each area investigated, the suitability of ground level wind conditions in terms of "comfort" and the presence of "hazards" was assessed based upon local hourly-mean wind speed as defined by the San Francisco Planning Code Section 148.

4.2. San Francisco Planning Environmental Review Guidelines and Criteria

Planning Code Section 148 establishes wind comfort and wind hazard criteria for certain zoning districts: The Downtown (C-3-G) Districts which includes the project site, the Downtown Residential (DTR) Districts, the Folsom and Main Residential/Commercial Special Use District, the Van Ness Special Use District, and certain zoning districts in the South of Market neighborhood. The Proposed Project is in the C-G-3 District so Section 148 of the Planning Code governs this development.

Planning Code Section 148 establishes equivalent wind speeds of 7 miles per hour (mph) as the comfort criterion for seating areas and 11 mph as the comfort criterion for areas of substantial pedestrian use. New buildings and additions to existing buildings may not cause ground-level winds to exceed 11 mph more than 10 percent of the time year-round between 7:00 AM and 6:00 PM.

If existing wind speeds exceed the comfort criteria, or when a project would result in new exceedances of the comfort criteria, the Planning Commission may grant an exception pursuant to Planning Code Section 309 provided that the building or addition cannot be designed to meet the comfort criteria without creating an unattractive and ungainly building form and without unduly restricting the development potential of the site. In granting an exception pursuant to Section 309, the Planning Commission must determine that the exceedances of the comfort criteria would be insubstantial because of the limited amount by which the comfort criteria are exceeded, the limited location in which the comfort criteria are exceeded, or the limited time during which the comfort criteria are exceeded.

Section 148 also establishes a wind hazard criterion of an equivalent wind speed of 26 mph as averaged over a single full hour of the year[1]. New buildings or additions to existing buildings may not cause ground-level winds to reach or exceed this wind speed for more than a single hour during the year. Exceptions pursuant to Section 309 are not permitted.

[1] The wind hazard criterion is derived from the 26 mph hourly average wind speed that would generate a 3-second gust of wind at 20 meters per second, a commonly used guideline for wind safety. The 26 mph hourly average is converted to a one-minute average of 36 mph, which is used to determine compliance with the 26 mph one-hour hazard criterion in the Planning Code. (Arens, E. *et al.,* "Developing the San Francisco Wind Ordinance and its

Guidelines for Compliance," *Building and Environment*, Vol. 24, No. 4, p. 297-303, 1989.)

5. Assessment Methodology

5.1. Boundary Layer Wind Tunnel Testing

Wind tunnel testing is a well-established and robust means of assessing the pedestrian wind microclimate. It enables the wind conditions at the site to be quantified and classified in accordance with the San Francisco Planning Code Section 148 Wind Speed Criteria.

Wind is unsteady or gusty, and this 'gustiness' or turbulence depends on the site. Modelling these effects is achieved by a series of grid, barrier and floor roughness elements to create an atmospheric boundary layer that is representative of urban or open country conditions, as is appropriate.

A 1:300 scale model of the existing buildings at and surrounding the project site up to a 1,500-foot radius of the center of the site was constructed along with a scale model of the project site. Wind speed measurements at assessment locations were made using probes capable of measuring fluctuating pressure differences that are calibrated against wind speed. A system of probes running simultaneously was used to obtain results from 85 test points for the Existing Scenario, Existing Plus Project Scenario, and Existing Plus Project with Mitigation Scenario at a height corresponding to 5 feet at full scale (i.e. pedestrian height).

Measurements were taken for 16 wind directions in increments of 22.5º (0° represents the compass north). The methodology for quantifying the ground level wind microclimate of the site is outlined below:

- Measure the building-induced wind speeds at ground level in the wind tunnel;
- Combine these with wind frequency statistics derived from the old San Francisco Federal Building at 50 United Nations Plaza to obtain the expected frequency and magnitude of wind speeds at ground level; and
- Compare the results with the Planning Code Section 148 Wind Speed Criteria to the conditions around the site in each scenario.

The technical details relating to the instrumentation, measurements and analysis for the wind study are described in Appendix D.

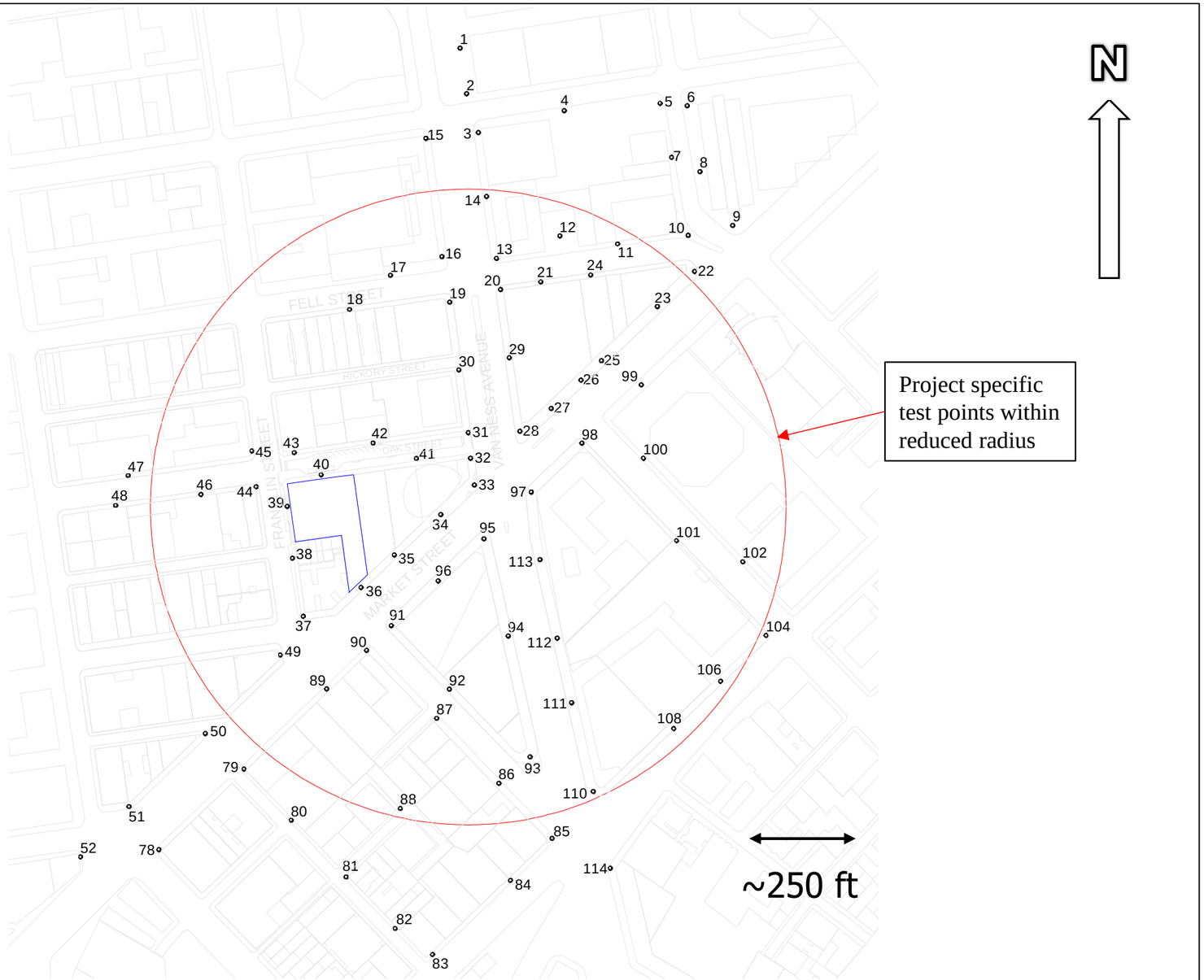
5.2. Test Points

A subset of 85 test points from the full "HUB EIR" are included in this wind tunnel test for the Existing Scenario, Existing Plus Project, and Existing Plus Project with Mitigation scenarios. The test points are selected within a 1,500-foot radius of the project site. The test points are positioned in key locations within the study area,

which are the areas of pedestrian use, including the locations on the sidewalks, street intersections as well as the open spaces. These test points have potential changes in wind speeds and turbulence levels within the development areas with the introduction of the Proposed Project.

The locations of the test points are distributed amongst study area streets as illustrated **Figure 5.1**. Additionally, a total of 58 project specific test points within a reduced coverage, approximately 700-foot radius of the project site (red circle) are selected to assess a more typical project specific scenario. The test point locations are the same for the Existing, Existing Plus Project, and Existing Plus Project with Mitigation Scenarios.

Figure 5.1: Test Point Map



432357 – 98 Franklin Test Points Map	BMT	Drawing No: 432357/FIG -5.1	By: T. Syafizan Date: July 27th, 2018

6. Wind Microclimate Results

Tables 6.1 to 6.2 show the wind comfort and hazard analysis results, respectively for:

- Existing Scenario
- Existing Plus Project Scenario
- Existing Plus Project with Mitigation Scenario

The tabular wind comfort results are expressed as the probability of exceeding the comfort 1-minute mean wind speed of 11 mph followed by the 1-minute mean wind speed that is exceeded 10% of the time. All of the points tested were on sidewalks, at corners with pedestrian crossings, or within the publicly accessible pedestrian use areas on the project site and within the relevant study area.

The tabular wind hazard results are presented as the probability of having an equivalent wind speed exceed the 26 mph mean-hourly wind speed hazard criterion for a full hour within any 1-year period, followed by the wind speed that is exceeded once per year and the number of hours that the hazard criterion of 26 mph is exceeded. As explained above in footnote 3 in subsection 4.2, the 26 mph hourly average is converted to a 1-minute mean of 36 mph, which is used to determine compliance with the 26 mph 1-hour hazard criterion in the Planning Code.

The results for the aforementioned configurations are also presented graphically as follows:

- **Figure 6.1a**: Wind comfort results for the Existing Scenario
- **Figure 6.1b**: Wind hazard results for the Existing Scenario
- **Figure 6.2a**: Wind comfort results for the Existing Plus Project Scenario
- **Figure 6.2b**: Wind hazard results for the Existing Plus Project Scenario
- **Figure 6.3a**: Wind comfort results for the Existing Plus in Mitigation Scenario
- **Figure 6.3b**: Wind hazard results for the Existing Plus in Mitigation Scenario

Table 6.1: Wind Comfort Analysis Results

Location Number	Project Specific Test Points	Comfort Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds
1	N	11	16	31%	e	16	29%	0	e	16	29%	0	e
2	N	11	19	40%	e	19	40%	0	e	19	40%	0	e
3	N	11	20	40%	e	20	39%	0	e	20	39%	0	e
4	N	11	13	18%	e	12	17%	0	e	13	18%	0	e
5	N	11	11	10%	e	11	10%	0	e	11	9%	0	-
6	N	11	24	50%	e	24	50%	0	e	24	50%	0	e
7	N	11	10	5%		9	5%	0		10	8%	1	
8	N	11	13	19%	e	13	19%	0	e	12	15%	-1	e
9	N	11	22	51%	e	22	51%	0	e	22	51%	0	e
10	N	11	25	51%	e	25	51%	0	e	25	51%	0	e
11	Y	11	14	25%	e	14	24%	0	e	15	29%	1	e
12	Y	11	18	41%	e	18	41%	0	e	18	41%	0	e
13	Y	11	28	55%	e	28	55%	0	e	28	55%	0	e
14	Y	11	10	6%		10	6%	0		11	10%	1	pp
15	N	11	16	30%	e	15	28%	0	e	15	29%	0	e
16	Y	11	16	31%	e	16	30%	0	e	16	32%	0	e
17	Y	11	11	9%		11	11%	0	p	11	10%	0	pp
18	Y	11	11	11%	e	10	7%	-1	-	10	7%	-1	-
19	Y	11	17	35%	e	17	35%	0	e	17	36%	0	e
20	Y	11	19	44%	e	19	44%	0	e	19	44%	0	e
21	Y	11	28	55%	e	28	55%	0	e	28	55%	0	e
22	N	11	17	35%	e	18	37%	0	e	17	36%	0	e
23	Y	11	12	15%	e	12	13%	-1	e	12	15%	0	e
24	Y	11	24	50%	e	24	50%	0	e	24	50%	0	e
25	Y	11	11	11%	e	11	10%	0	e	11	11%	0	e
26	Y	11	11	11%	e	12	12%	0	e	11	11%	0	e
27	Y	11	11	8%		11	9%	0		11	9%	0	
28	Y	11	17	36%	e	18	40%	1	e	18	38%	1	e
29	Y	11	20	44%	e	20	44%	0	e	20	44%	0	e
30	Y	11	18	34%	e	17	34%	0	e	18	36%	1	e
31	Y	11	12	17%	e	14	25%	2	e	12	14%	0	e
32	Y	11	11	11%	e	19	36%	7	e	15	28%	4	e
33	Y	11	11	11%	e	20	38%	9	e	17	33%	6	e
34	Y	11	13	17%	e	19	39%	6	e	18	37%	5	e
35	Y	11	9	4%		12	13%	2	p	12	13%	2	pp

Table 6.1: Wind Comfort Analysis Results (continued)

Location Number	Project Specific Test Points	Comfort Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds
36	Y	11	18	39%	e	13	20%	-4	e	14	23%	-4	e
37	Y	11	14	23%	e	23	48%	9	e	18	37%	4	e
38	Y	11	8	1%		17	35%	9	p	13	19%	5	pp
39	Y	11	12	16%	e	10	7%	-2	-	10	7%	-2	-
40	Y	11	15	30%	e	12	14%	-3	e	9	4%	-6	-
41	Y	11	18	39%	e	26	51%	9	e	15	29%	-2	e
42	Y	11	13	22%	e	16	32%	3	e	13	17%	-1	e
43	Y	11	15	30%	e	16	34%	0	e	13	18%	-3	e
44	Y	11	8	2%		16	35%	8	p	16	34%	8	pp
45	Y	11	11	10%		13	23%	3	p	14	25%	3	pp
46	N	11	11	9%		12	14%	1	p	12	16%	1	pp
47	N	11	10	5%		9	3%	-1		10	5%	0	
48	Y	11	11	8%		10	5%	-1		10	5%	-1	
49	N	11	14	20%	e	14	22%	0	e	14	21%	0	e
50	N	11	10	6%		10	8%	0		10	7%	0	
51	N	11	13	18%	e	13	19%	0	e	14	21%	1	e
52	N	11	8	2%		8	1%	0		8	2%	0	
78	N	11	12	17%	e	12	17%	0	e	13	19%	0	e
79	N	11	12	15%	e	13	18%	1	e	12	16%	0	e
80	N	11	10	7%		11	11%	1	p	11	10%	1	
81	N	11	12	15%	e	12	14%	0	e	12	14%	0	e
82	N	11	10	7%		11	8%	0		10	6%	0	
83	N	11	12	15%	e	13	17%	0	e	12	15%	0	e
84	N	11	9	4%		9	5%	0		9	2%	-1	
85	Y	11	14	24%	e	13	21%	-1	e	12	16%	-2	e
86	Y	11	12	16%	e	12	17%	0	e	12	15%	0	e
87	Y	11	13	21%	e	12	13%	-1	e	12	13%	-1	e
88	Y	11	10	5%		10	6%	0		10	6%	0	
89	Y	11	12	15%	e	13	21%	1	e	14	23%	2	e
90	Y	11	11	10%	e	15	28%	4	e	14	24%	3	e
91	Y	11	15	28%	e	15	26%	0	e	14	24%	-1	e
92	Y	11	11	9%		15	26%	5	p	15	25%	4	pp
93	Y	11	15	31%	e	15	32%	0	e	15	29%	0	e
94	Y	11	11	9%		12	15%	1	p	12	14%	1	pp
95	Y	11	11	11%	e	15	27%	4	e	15	26%	3	e

Table 6.1: Wind Comfort Analysis Results (continued)

Location Number	Project Specific Test Points	Comfort Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds
96	Y	11	14	24%	e	18	39%	4	e	17	36%	3	e
97	Y	11	15	28%	e	15	32%	1	e	16	33%	1	e
98	Y	11	15	28%	e	17	36%	2	e	15	29%	0	e
99	Y	11	10	6%		10	4%	0		9	3%	-1	
100	Y	11	12	13%	e	13	18%	1	e	11	11%	0	e
101	Y	11	20	42%	e	17	39%	-2	e	17	39%	-2	e
102	Y	11	21	42%	e	19	41%	-1	e	19	41%	-1	e
104	N	11	19	39%	e	16	32%	-3	e	18	36%	-1	e
106	Y	11	17	34%	e	15	27%	-2	e	15	27%	-2	e
108	Y	11	12	13%	e	12	13%	0	e	12	15%	1	e
110	Y	11	19	42%	e	19	42%	0	e	19	42%	0	e
111	Y	11	8	1%		9	2%	0		9	4%	1	
112	Y	11	13	17%	e	12	17%	0	e	12	14%	-1	e
113	Y	11	12	12%	e	14	25%	3	e	14	22%	2	e
114	N	11	22	47%	e	20	43%	-2	e	20	43%	-2	e

All Test Points

Average	Average	Sum
14.2	**22%**	**64**
Existing, e		64

Average	Average	Average	Sum
15.1	**25%**	**0.9**	**71**
Existing, e			62
New, due to Existing Plus Project Scenario, p			9
Eliminated by Existing Plus Project Scenario, -			2

Average	Average	Average	Sum
14.6	**24%**	**0.4**	**69**
Existing, e			60
Existing Plus Project Scenario, p			0
New, due to Existing Plus Project Scenario, pp			9
Existing Eliminated Existing Plus Project with Mitigation Scenario, -			4
Existing Plus Project Eliminated Existing Plus Project with Mitigation Scenario, --			0

Project Specific Test Points

Average	Average	Sum
14.1	**22%**	**45**
Existing, e		45

Average	Average	Average	Sum
15.4	**27%**	**1.4**	**51**
Existing, e			43
New, due to Existing Plus Project Scenario, p			8
Eliminated by Existing Plus Project Scenario, -			2

Average	Average	Average	Sum
14.7	**25%**	**0.6**	**51**
Existing, e			42
Existing Plus Project Scenario, p			0
New, due to Existing Plus Project Scenario, pp			9
Existing Eliminated Existing Plus Project with Mitigation Scenario, -			3
Existing Plus Project Eliminated Existing Plus Project with Mitigation Scenario, --			0

[3] Year Round between 7 a.m. and 6 p.m.

Table 6.2: Wind Hazard Analysis Results

Location Number	Project Specific Test Points	Hazard Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds
1	N	36	37	1	e	35	0	-1	-	35	0	-1	-
2	N	36	44	14	e	42	12	-2	e	42	12	-2	e
3	N	36	47	19	e	44	15	-4	e	44	15	-4	e
4	N	36	24	0		23	0			24	0		
5	N	36	30	0		30	0			34	0		
6	N	36	48	43	e	48	43	0	e	48	43	0	e
7	N	36	26	0		26	0			28	0		
8	N	36	27	0		26	0			28	0		
9	N	36	43	12	e	43	12	0	e	43	12	0	e
10	N	36	49	54	e	53	53	-1	e	53	53	-1	e
11	Y	36	28	0		26	0			28	0		
12	Y	36	54	14	e	38	2	-12	e	38	2	-12	e
13	Y	36	52	119	e	52	119	0	e	52	119	0	e
14	Y	36	24	0		22	0			23	0		
15	N	36	32	0		32	0			32	0		
16	Y	36	30	0		31	0			33	0		
17	Y	36	24	0		29	0			26	0		
18	Y	36	24	0		23	0			23	0		
19	Y	36	32	0		32	0			32	0		
20	Y	36	36	1	e	36	1	0	e	36	1	0	e
21	Y	36	53	138	e	53	138	0	e	53	138	0	e
22	N	36	33	0		34	0			33	0		
23	Y	36	25	0		24	0			25	0		
24	Y	36	44	24	e	44	24	0	e	44	24	0	e
25	Y	36	32	0		32	0			32	0		
26	Y	36	34	0		35	0			36	0		
27	Y	36	32	0		34	0			34	0		
28	Y	36	32	0		35	0			34	0		
29	Y	36	38	2	e	38	2	0	e	38	2	0	e
30	Y	36	34	0		33	0			35	0		
31	Y	36	31	0		34	0			32	0		
32	Y	36	24	0		37	1	1	p	30	0		
33	Y	36	26	0		40	4	4	p	33	0		
34	Y	36	30	0		38	1	1	p	35	0		
35	Y	36	19	0		27	0			25	0		

Table 6.2: Wind Hazard Analysis Results (continued)

Location Number	Project Specific Test Points	Hazard Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds
36	Y	36	35	0		27	0			28	0		
37	Y	36	27	0		43	15	15	p	35	0		
38	Y	36	20	0		32	0			25	0		
39	Y	36	26	0		29	0			21	0		
40	Y	36	32	0		31	0			22	0		
41	Y	36	33	0		49	69	69	p	35	0		
42	Y	36	30	0		41	3	3	p	28	0		
43	Y	36	30	0		38	1	1	p	29	0		
44	Y	36	19	0		34	0			34	0		
45	Y	36	28	0		32	0			35	0		
46	N	36	24	0		25	0			27	0		
47	N	36	23	0		23	0			24	0		
48	Y	36	21	0		20	0			20	0		
49	N	36	27	0		28	0			27	0		
50	N	36	23	0		23	0			23	0		
51	N	36	25	0		25	0			26	0		
52	N	36	18	0		19	0			17	0		
78	N	36	25	0		24	0			25	0		
79	N	36	23	0		24	0			23	0		
80	N	36	19	0		21	0			21	0		
81	N	36	22	0		22	0			22	0		
82	N	36	23	0		23	0			21	0		
83	N	36	24	0		24	0			23	0		
84	N	36	21	0		20	0			20	0		
85	Y	36	26	0		25	0			24	0		
86	Y	36	26	0		26	0			26	0		
87	Y	36	24	0		24	0			24	0		
88	Y	36	20	0		20	0			20	0		
89	Y	36	24	0		25	0			25	0		
90	Y	36	21	0		29	0			26	0		
91	Y	36	29	0		29	0			28	0		
92	Y	36	22	0		31	0			30	0		
93	Y	36	31	0		29	0			30	0		
94	Y	36	25	0		25	0			25	0		
95	Y	36	22	0		28	0			27	0		

Table 6.2: Wind Hazard Analysis Results (continued)

Location Number	Project Specific Test Points	Hazard Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds
96	Y	36	28	0		32	0			31	0		
97	Y	36	38	1	e	40	2	1	e	37	1	0	e
98	Y	36	29	0		32	0			32	0		
99	Y	36	25	0		23	0			24	0		
100	Y	36	24	0		25	0			23	0		
101	Y	36	37	1	e	35	0	-1	-	35	0	-1	-
102	Y	36	40	5	e	38	2	-3	e	38	2	-3	e
104	N	36	36	1	e	30	0	-1	-	33	0	-1	-
106	Y	36	32	0		30	0			30	0		
108	Y	36	25	0		25	0			27	0		
110	Y	36	35	0		35	0			35	0		
111	Y	36	20	0		20	0			21	0		
112	Y	36	25	0		24	0			23	0		
113	Y	36	27	0		28	0			29	0		
114	N	36	41	8	e	38	3	-5	e	38	3	-5	e

All Test Points

Average	Sum	Sum
29.7	**457**	**17**
Existing, e		17

Average	Sum	Sum	Sum
31.2	**522**	**65**	**21**
Existing, e			14
New, due to Existing Plus Project Scenario, p			7
Eliminated by Existing Plus Project Scenario, -			3

Average	Sum	Sum	Sum
30.3	**427**	**-30**	**14**
Existing, e			14
Existing Plus Project Scenario, p			0
New, due to Existing Plus Project Scenario, pp			0
Existing Eliminated Existing Plus Project with Mitigation Scenario, -			3
Existing Plus Project Eliminated Existing Plus Project with Mitigation Scenario, --			0

Project Specific Test Points

Average	Sum	Sum
29.6	**305**	**9**
Existing, e		9

Average	Sum	Sum	Sum
32.0	**384**	**79**	**15**
Existing, e			8
New, due to Existing Plus Project Scenario, p			7
Eliminated by Existing Plus Project Scenario, -			1

Average	Sum	Sum	Sum
30.6	**289**	**-16**	**8**
Existing, e			8
Existing Plus Project Scenario, p			0
New, due to Existing Plus Project Scenario, pp			0
Existing Eliminated Existing Plus Project with Mitigation Scenario, -			1
Existing Plus Project Eliminated Existing Plus Project with Mitigation Scenario, --			0

Figure 6.1a: Wind Comfort Results - Existing Scenario

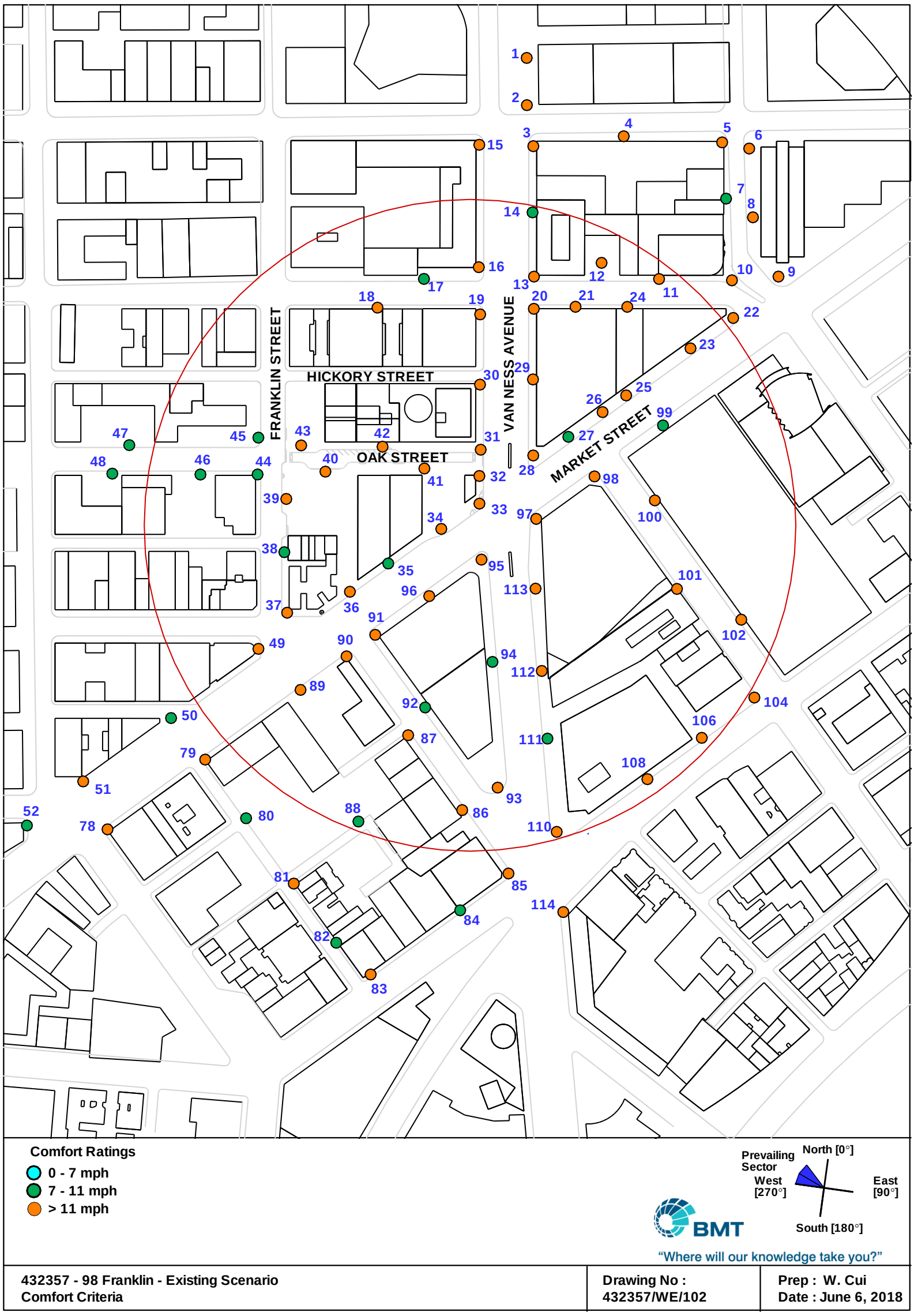


Figure 6.1b: Wind Hazard Results - Existing Scenario

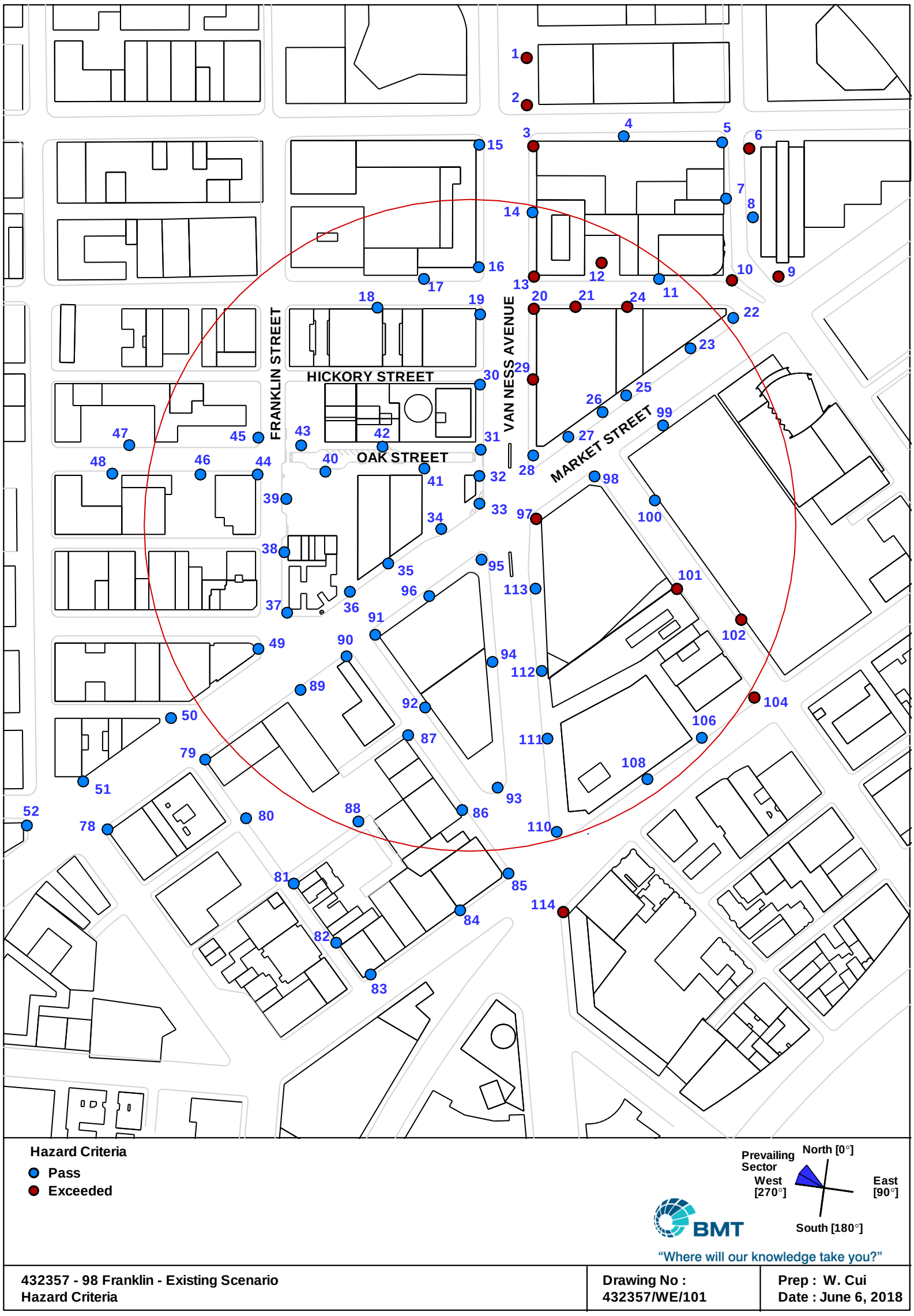


Figure 6.2a: Wind Comfort Results – Existing Plus Project Scenario

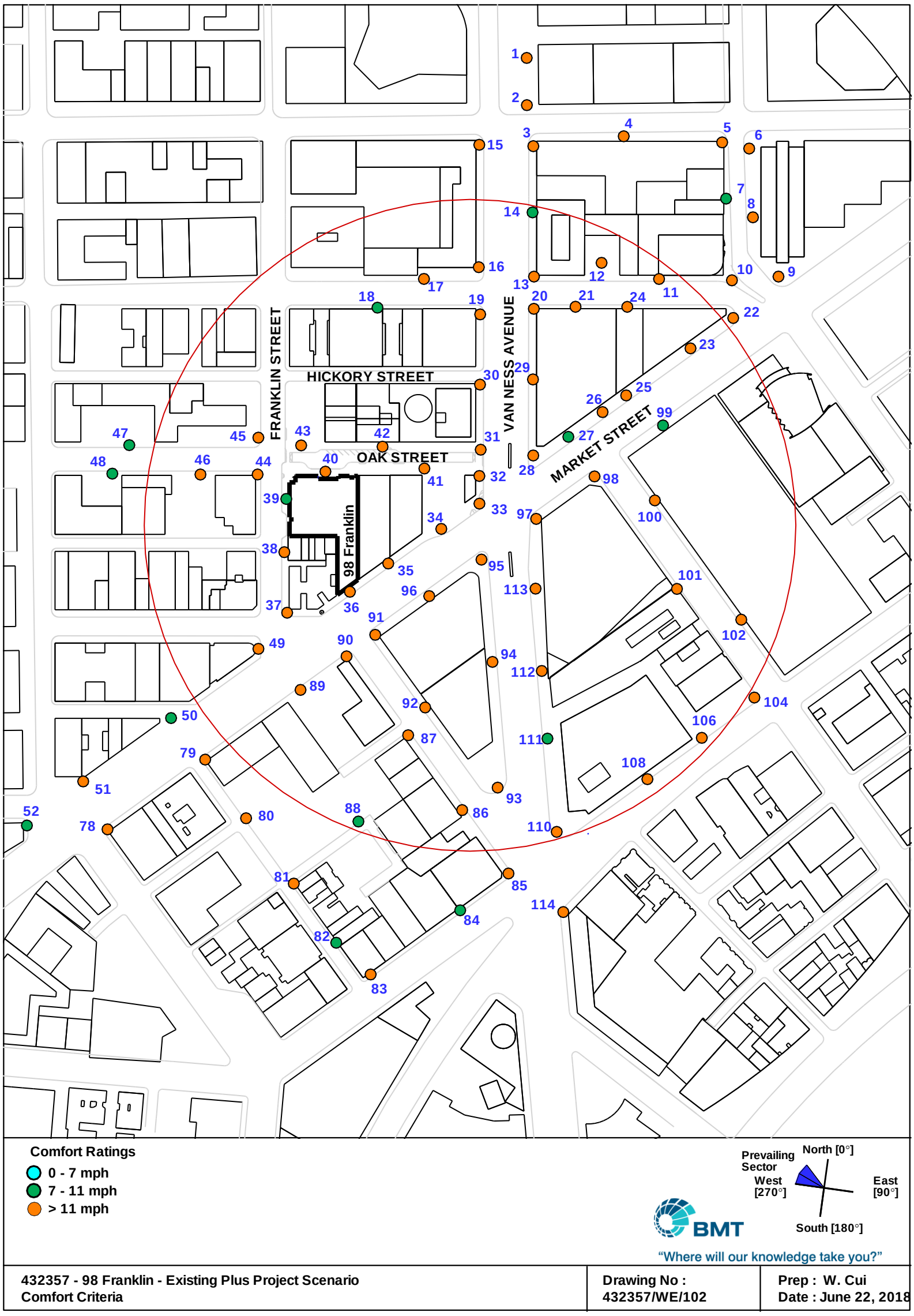


Figure 6.2b: Wind Hazard Results – Existing Plus Project Scenario

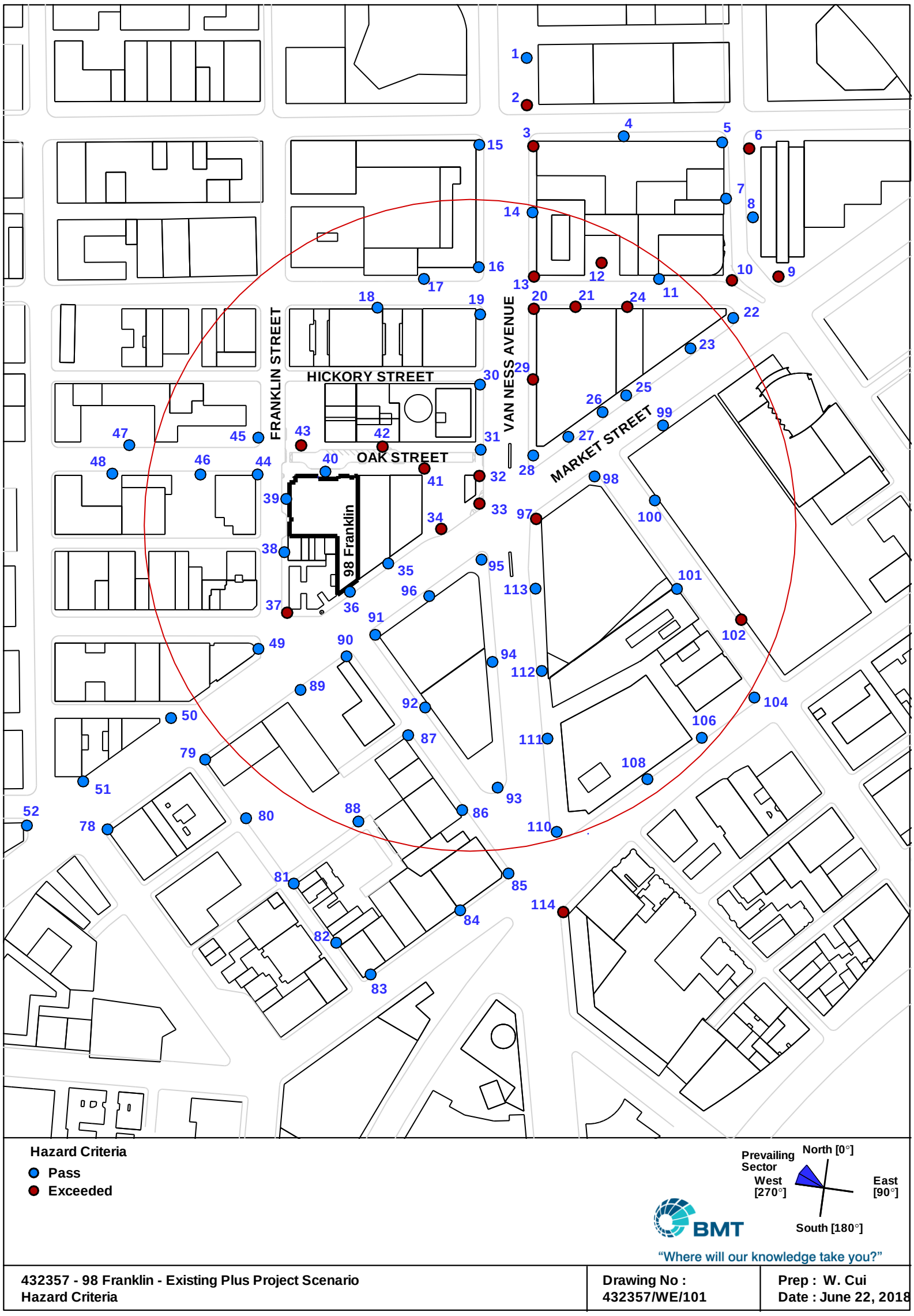


Figure 6.3a: Wind Comfort Results – Existing Plus Project with Mitigation Scenario

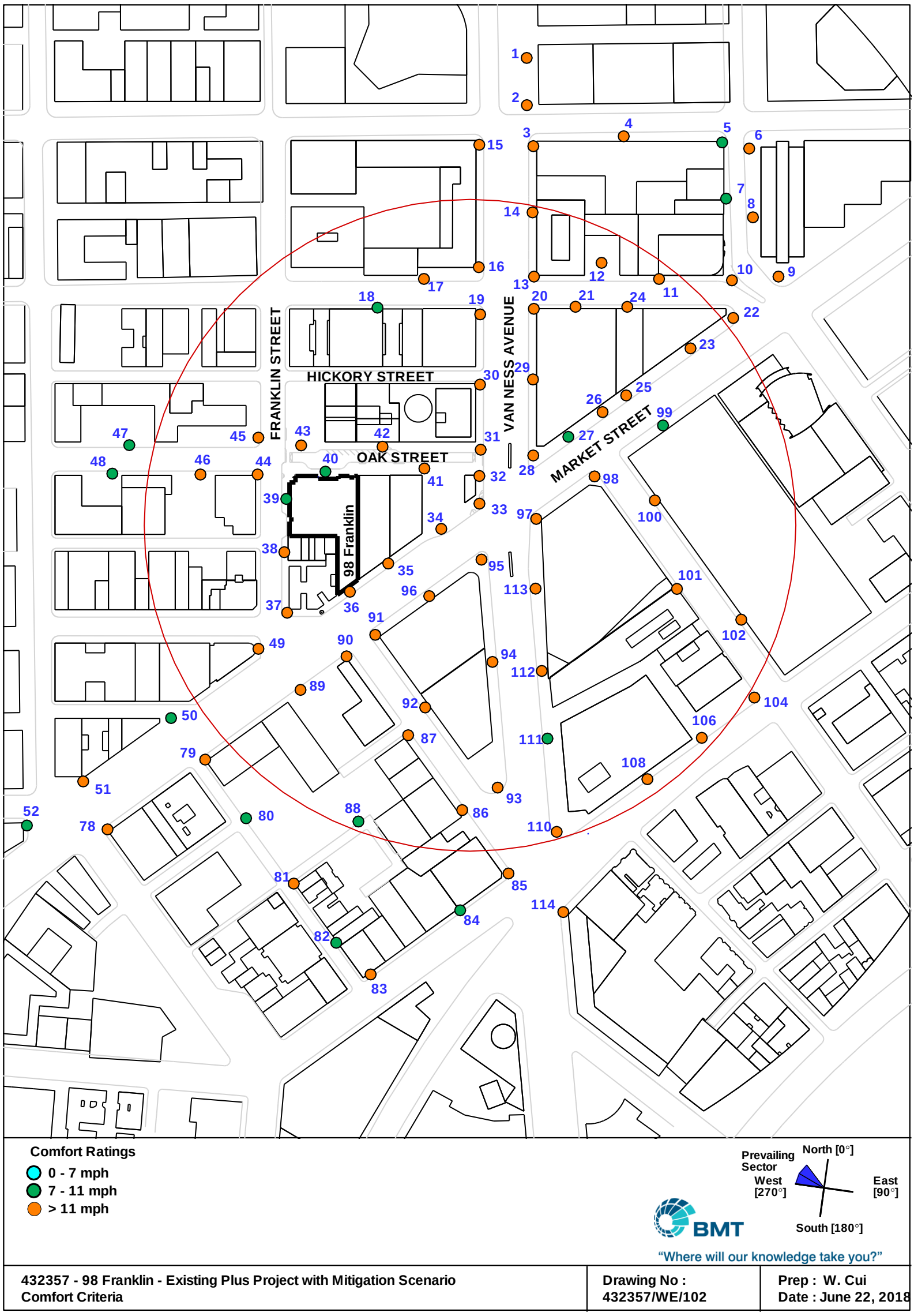
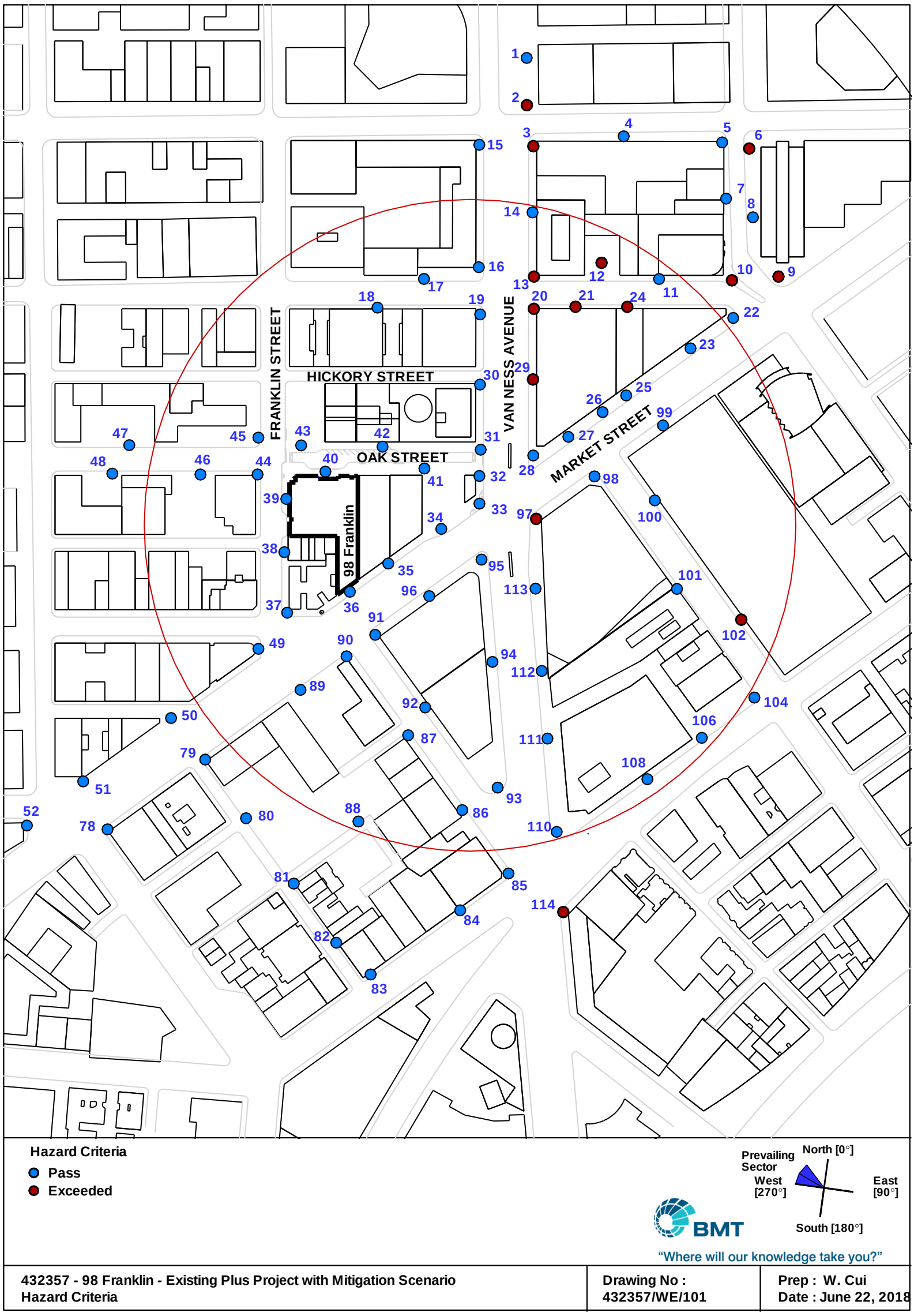


Figure 6.3b: Wind Hazard Results – Existing Plus Project with Mitigation Scenario



7. Discussion of Results

7.1. Existing Scenario

Existing wind conditions in the project site's vicinity are generally characterized as windy. The site and surroundings are subject to winds in excess of the City's comfort criteria for more than 10% of the time during the year in multiple test points. The site and surrounding study area is also prone to wind hazards at a few test points on the eastern side of the project site.

7.1.1. Wind Comfort Criterion

The study area is windy with wind conditions at 64 out of the 85 total test points exceeding the comfort criterion specified in Section 148 of the San Francisco Planning Code. The average year-round wind speed exceeded 10% of the time, between 7 a.m. and 6 p.m., for all test points is 14.2 mph, which is higher than the City's 11 mph comfort criterion for areas of pedestrian use (see **Table 6.1** and **Figure 6.1a**).

The wind conditions at 45 out of 58 the total project specific test points within the reduced radius exceeding the comfort criterion specified in Section 148 of the San Francisco Planning Code. The average year-round wind speed exceeded 10% of the time, between 7 a.m. and 6 p.m., for all test points is 14.1 mph, which is higher than the City's 11 mph comfort criterion for areas of pedestrian use.

7.1.2. Wind Hazard Criterion

Within the Existing Scenario, wind conditions exceed the hazard criterion at 17 out of 85 test points. The total number of hazard exceedance hours is 457 (see **Table 6.2** and **Figure 6.1b**). The test points at which wind conditions exceed the hazard criteria are located along the eastern sidewalk of the Van Ness Avenue (test points 1, 2, 3, 13, 20, 29, 97 and 114), along Polk Street (test point 6), along Fell Street (test points 9, 10, 12, 21 and 24) and along 11th Street (test points 101, 102, and 104).

The wind conditions at 9 out of 58 total project specific test points within the reduced radius exceeding the hazard criterion. The total number of hazard exceedance hours is 305. The test points at which wind conditions exceed the hazard criteria are located along the eastern sidewalk of the Van Ness Avenue (test points 13, 20, 29 and 97), along Fell Street (test points 12, 21 and 24) and along 11th Street (test points 101 and 102).

7.2. Existing Plus Project Scenario

The assessment indicates that for the Project Scenario located within the existing setting, wind conditions would be slightly worse in terms of wind comfort and wind hazard, compared to the Existing Scenario.

7.2.1. Wind Comfort Criterion

In terms of comfort, the average year-round wind speed, exceeded 10% of the time, between 7 a.m. and 6 p.m., for all test locations would slightly increase from 14.2 mph to 15.1 mph, which remains higher than the 11 mph comfort criterion for areas of pedestrian use. Wind conditions at a total of 71 out of 85 test points would exceed the comfort criterion for the Existing Plus Project Scenario (see **Table 6.1** and **Figure 6.2a**). The test points at which wind conditions are improved and satisfy the comfort criteria are along Fell Street (test point 18) and along Franklin Street (test point 39). However, the test points at which wind conditions exceed the comfort criteria attributable to the Project are along Fell Street (test point 17), along Market Street (test point 35), along Franklin Street (test point 38), along Oak Street (test points 44, 45, and 46), along Brady Street (test point 80), along 12th Street (test point 92) and along Van Ness Avenue (test point 94).

Wind conditions at a total of 51 out of 58 project specific test points within reduced radius would exceed the comfort criterion for the Existing Plus Project Scenario. The project specific test points within the reduced radius at which wind conditions are improved and satisfy the comfort criteria are along Fell Street (test point 18) and along Franklin Street (test point 39). However, the test points at which wind conditions exceed the comfort criteria attributable to the Project are along Franklin Street (test point 38), along Oak Street (test points 44, 45, and 46), along 12th Street (test point 92) and along Van Ness Avenue (test point 94).

7.2.2. Wind Hazard Criterion

The number of test points in which wind conditions exceed the hazard criterion would be increased from 17 in the Existing Scenario to 21 in the Existing Plus Project Scenario. Additionally, the total duration of hazardous wind conditions would be increased from 457 hours to 522 hours, representing a net increment of 65 hours of hazardous wind conditions compared to the Existing Scenario (see **Table 6.2** and **Figure 6.2b**). The test points at which wind conditions are improved and satisfy the comfort criteria are along Van Ness Avenue (test point 1) and along 11th Street (test points 101 and 104). However, the test points at which wind conditions exceed the hazard criteria attributable to the Project are along Van Ness Avenue (test points 32 and 33), along Market Street (test points 34 and 37) and along Oak Street (test points 41, 42 and 43).

The wind conditions at project specific test point within the reduced radius exceed the hazard criteria would be increased from 9 in the Existing Scenario to 15 in the Existing Plus Project Scenario. The total duration of hazardous wind conditions would be increased from 305 hours to 384 hours, representing a net increment of 79 hours of hazardous wind conditions compared to Existing Scenario. The project

specific test points within the reduced radius at which wind conditions are improved and satisfy the hazard criteria is along 11th Street (test point 101). However, the project specific test points within the reduced radius at which wind conditions exceed the hazard criteria attributable to the Project are along Van Ness Avenue (test points 32 and 33), along Market Street (test points 34 and 37) and along Oak Street (test points 41, 42 and 43).

7.3. Existing Plus Project with Mitigation Scenario

The assessment indicates that in the Existing Plus Project with Mitigation Scenario wind conditions would be better compared to the Existing and Existing Plus Project Scenario. The proposed trees and canopy shield pedestrians from downdrafts caused by the Project, reducing pedestrian level winds and creating a more favorable wind microclimate near the Project.

7.3.1. Wind Comfort Criterion

Within the Existing Plus Project with Mitigation Scenario, wind conditions would exceed the comfort criterion at 69 out of 85 test points, which would represent a net decrement of 2 test points compared to the Existing Plus Project Scenario (see **Table 6.1** and **Figure 6.3a**). The test points at which wind conditions are improved and satisfy the comfort criteria are along Hayes Street (test point 5), along Oak Street (test point 40) and along Brady Street (test point 80). However, the test point at which wind conditions exceed the comfort criteria is along Van Ness Avenue (test point 14).

Wind conditions at a total of 51 out of 58 project specific test points within reduced radius would exceed the comfort criterion for the Existing Plus Project with Mitigation Scenario. The project specific test point within the reduced radius at which wind conditions exceed the comfort criteria attributable to the Project is along Van Ness Avenue (test point 14).

7.3.2. Wind Hazard Criterion

The number of test points in which wind conditions exceed the hazard criterion would be decreased from 17 in the Existing Scenario to 14 in the Existing Plus Project with Mitigation Scenario. The total duration of hazardous wind conditions would be decreased from 457 hours to 427 hours, representing a net decrement of 30 hours of hazardous wind conditions compared to Existing Scenario.

The wind conditions at project specific test points within the reduced radius exceed the hazard criteria would be decreased from 9 in the Existing Scenario to 8 in the Existing Plus Project with Mitigation Scenario. The total duration of hazardous wind conditions would be decreased from 305 hours to 289 hours, representing a net decrement of 16 hours of hazardous wind conditions compared to Existing Scenario.

8. Conclusions

The boundary layer wind tunnel study has assessed the wind microclimate in the 98 Franklin Street study area. On the basis of the wind tunnel modelling, the following conclusions have been drawn:

- Within the Existing Scenario, wind conditions exceed the comfort criterion at 64 out of 85 test points, with a combined average hourly wind speed of 14.2 mph. Under the Existing Scenario, wind conditions exceed the hazard criterion at 17 out of 85 test points, which collectively exceed the hazard criterion for a duration of 457 hours annually.

- Within the Existing Plus Project Scenario, wind conditions would exceed the comfort criterion at 71 out of 85 test points, which would represent a net increment of 7 test points compared to Existing Scenario. The average wind speed over all the test points would be increased from 14.2 mph in the Existing Scenario to 15.1 mph in the Existing Plus Project Scenario. The number of test points in which wind conditions exceed the hazard criterion would be increased from 17 in the Existing Scenario to 21 in the Existing Plus Project Scenario. Additionally, the total duration of hazardous wind conditions would be increased from 457 hours to 522 hours, representing a net increment of 65 hours of hazardous wind conditions compared to the Existing Scenario.

- Within the Existing Plus Project with Mitigation Scenario, wind conditions would exceed the comfort criterion at 69 out of 85 test points, which would represent a net decrement of 2 test points compared to the Existing Plus Project Scenario. The number of test points in which wind conditions exceed the hazard criterion would be decreased from 17 in the Existing Scenario to 14 in the Existing Plus Project with Mitigation Scenario. The total duration of hazardous wind conditions would be decreased from 457 hours to 427 hours, representing a net decrement of 30 hours of hazardous wind conditions compared to the Existing Scenario.

Appendix A 98 Franklin Scope of Work

BMT is pleased to submit this scope of work to perform a wind study for pedestrian comfort as well as to assess the potential for pedestrian wind hazards for the Proposed Project, herein referred to as the "Project". The following includes our understanding of the Project and the San Francisco Planning Department's requirements. Our proposed work plan and schedule to perform each task for the wind study are below

Project Understanding

The 23,753-square-foot project site is located on the block bounded by Market Street to the south, Franklin Street to the west, Oak Street to the north, and Van Ness Avenue to the east in the Civic/Downtown neighborhood, and within the C-3-G (Downtown-General) District and Van Ness and Market Downtown Residential Special Use District (Van Ness and Market Downtown Residential SUD). The project site is currently developed with a surface parking lot, which provides 135 vehicle parking spaces and fronts on Franklin, Market, and Oak streets. The proposed project would remove the parking lot and construct a 380-foot-tall, mixed-use building approximately 469,100 square feet in size. The proposed project would include 75,000 square feet of institutional space for the French American International School (on levels 1- 5 including 30-40 classrooms), 345 dwelling units, 3,100 square feet of commercial/retail space (within two ground-level storefronts), and 29,117 square feet of vehicle parking (within two basement levels). The proposed development would be part of the existing French American International School (FAIS) campus, which is currently located at 150 Oak Street, about one block northwest of the project site.

Proposed Work Plan

Task #1: Test Definition and Test Plan

BMT will define and present an adequate test plan to the San Francisco Planning Department staff for their review and approval, after review of the plans and consulting with SOM Architects, if necessary (the architects and project sponsors shall not direct any wind consultant work), and work with them to resolve any questions with the plan. The test plan will identify the locations of the test points and the buildings to be included in each scenario. The three scenarios to be customarily tested are the Existing Scenario, Project Scenario and Project with Mitigation Scenario.

Task #2: Model Construction

BMT will construct a 1:300 scale model of the Project using high density foam based upon design information provided by the project architects. BMT will also construct an existing context model of the surrounding buildings upwards to a radial distance of 1,500 feet, to properly simulate the existing winds in the project vicinity. The buildings falling outside the radial distance of 1,500 feet are relatively distant

from the project, thus the project unlikely makes a noticeable impact to the wind conditions around the areas beyond 1,500 feet from the project.

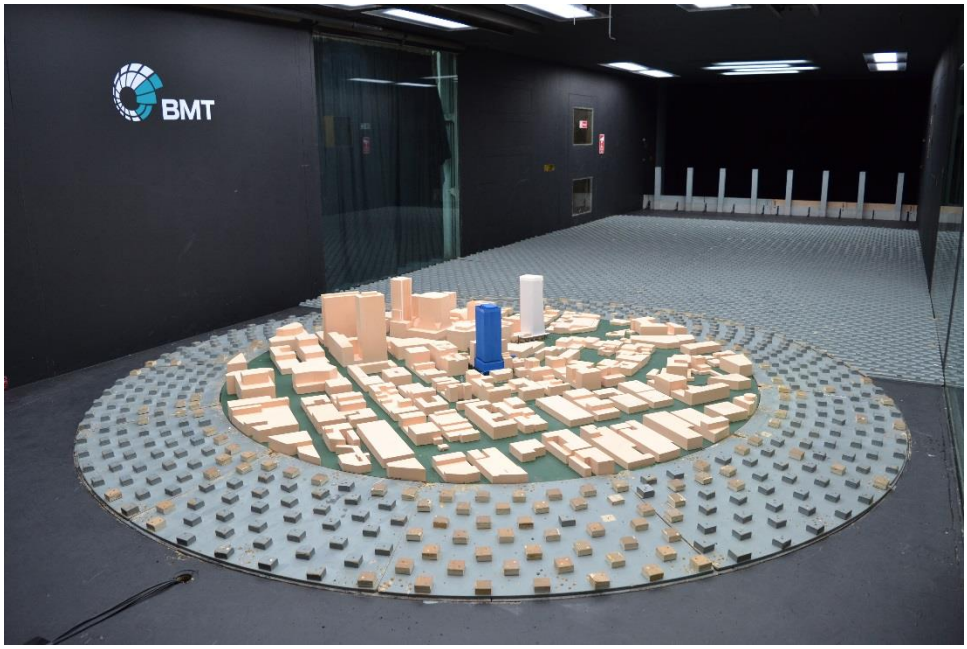
Task #3: Wind Tunnel Tests

BMT will conduct wind tunnel testing for 16 wind directions (in increments of 22.5 degrees) at all test point locations for each of the three scenarios, namely: 3a) the existing condition, including buildings currently under construction; 3b) the proposed project in the existing surrounding condition; 3c) the proposed project with mitigation in the existing surrounding conditions.

The actual composition and setup of the wind tunnel models for the three scenarios and each individual wind direction will be based on the expert judgement of the wind tunnel technical staff of BMT, as part of developing the Test Plan (Task #1).

The existing condition will include all of the existing buildings in and around the Proposed Project development site. An example of the wind tunnel model covering the existing developments is given in **Figure A.1**.

Figure A.1: Wind tunnel model covering existing developments



Task #4: Test Data Analysis / Evaluation / Wind Test Report

The testing, data reduction and evaluation will conform to protocols and requirements for such wind- tunnel tests for buildings in San Francisco. BMT, in collaboration with Related, will prepare a Technical Memorandum for submittal to the Planning Department, in order to report the findings of the wind tunnel test for the three scenarios. The final version of the report will address all comments and edits from the City's Planning Department.

The methodology for quantifying the pedestrian-level wind microclimate of the site is outlined below:

- Measure the building-induced wind speeds at pedestrian level in the wind tunnel;
- Combine these with wind frequency statistics derived from the old San Francisco Federal Building at 50 United Nations Plaza to obtain the expected frequency and magnitude of wind speeds at pedestrian level; and
- Compare the results with the San Francisco Planning Code Section 148 Wind Speed Criteria to the conditions around the site.

The wind tunnel data will be output measuring two specific conditions: potential for the project (in three test scenarios) to exceed the hazard criterion; as well as potential for the project to exceed the comfort criterion. Both sets of results will be presented in the Technical Memorandum. The wind hazard results will be presented as the probability of having a wind speed exceed the 26-mph equivalent wind speed hazard criterion for a full hour within any one-year period followed by the wind speed that is exceeded once per year and the number of hours that the hazard criterion of 26-mph is exceeded. The wind comfort results will be given as the probability of having the comfort equivalent wind speed of 11-mph exceeded followed by the equivalent wind speed that is exceeded 10% of the time.

Appendix B San Francisco Planning Code Section 148

B.1. Reduction of Ground Level Wind Currents

1. ***Requirement***: New buildings and additions to existing buildings shall be shaped, or other wind-baffling measures shall be adopted, so that the developments would not cause ground-level wind currents to exceed, more than 10 percent of the time year-round, between 7:00 am and 6:00 pm, the comfort level of 11 mph equivalent wind speed in areas of substantial pedestrian use and seven mph equivalent wind speed in public seating areas. The term "***equivalent*** wind speed" shall mean the wind speed adjusted to incorporate the effects of gustiness or turbulence on pedestrians.

2. When pre-existing ambient wind speeds exceed the comfort level, or when a proposed building or addition may cause ambient wind speeds to exceed the comfort level, the building shall be designed to reduce the ambient wind speeds to meet the requirements.

3. ***Exception:*** The Zoning Administrator may allow the building or addition to add to the amount of time the comfort level is exceeded by the least practical amount if (i) it can be shown that a building or addition cannot be shaped and other wind- baffling measures cannot be adopted to meet the foregoing requirements without creating an unattractive and ungainly building form and without unduly restricting the development potential of the project site in question, and (ii) ***the*** Zoning Administrator concludes that, because of the limited amount by which the comfort level is exceeded, the addition is insubstantial. The Zoning Administrator shall not grant an exception, and, no building or addition shall be permitted that causes equivalent winds speeds to reach or exceed the hazard level of 26 miles per hour for a single hour of the year.

4. ***Procedures:*** Procedures and methods for implementing this Section shall be specified by the Environmental Review Officer of the Planning Department.

Appendix C Quality Assurance

BMT is an accredited boundary layer wind tunnel testing facility and computational flow modelling organization. BMT holds certification for quality assurance of wind engineering services to ISO 9001:2008.

The team assigned to this work will be highly dedicated to achieving a successful project. The team is experienced at providing a fully integrated and collaborative approach to the working stream.

The Technical Director together with the three acting Line Managers will hold overall responsibility for the works on the project. The Project Manager will have responsibility for the direct management of the project including planning, monitoring progress, and final reporting. They will liaise with the client on all aspects of the project.

The project team is supported by an experienced group of dedicated specialists such as instrumentation engineers, wind tunnel operators, CAD specialists, and model makers.

Each and every member of the team has considerable experience in relation to wind environment testing for numerous developments across the globe ranging from masterplans to high-rise buildings to large-span roof structures.

For the all works completed standardized technical procedures are applied.

Appendix D Wind Tunnel & Model Details

D.1. Wind Tunnel Specifications

All the tests were conducted in BMT's Boundary Layer Wind Tunnel which has a test section 15.7-foot wide, 7.9-foot high and 49.2-foot long with a 14.4-foot diameter multiple plate turntable and a remotely controlled 3-dimensional traversing system. The operating wind speed range is 0.45 – 100.7mph.

The turbulent boundary layer is set up using an arrangement of roughness elements distributed over the floor of the wind tunnel, vertical posts and a 2D barrier placed at the entrance to the test section according to the upwind fetch.

D.2. Model

D.2.1. Information

The models of the proposed development were constructed based on 3D drawing information supplied by the project sponsor and the project architects. The wind tunnel models representative of the surrounding building morphology was constructed by BMT based on information provided by the project architects and the San Francisco Planning Department, in conjunction with a BMT site survey. The models were reviewed and approved by the design team, prior to testing.

D.2.2. Scale

A model scale of 1:300 has been adopted. At this scale the model is large enough to allow a good representation of the details that are likely to affect the local and overall wind flows at full scale. In addition, this scale enables a good simulation of the turbulence properties of the wind to be achieved.

D.2.3. Construction

The surrounding buildings are represented by high-density foam blocks to a sufficient level of detail to reproduce the wind flows at the location of the Proposed Project. The model is mounted on a 9.8-foot diameter baseboard and installed on the 14.4-foot diameter large turntable of BMT's Boundary Layer Wind Tunnel. In the region beyond the detailed surrounds model, the terrain is modelled as generalized roughness.

D.2.4. Model Photos

Images of the wind tunnel model are presented as follows:

- **Figures D.1** and **D.2** - Existing Scenario
- **Figures D.3** and **D.4** - Existing Plus Project Scenario
- **Figures D.5** - Wind Mitigation Measures

Figure D.1: Existing Scenario (Close-up), Viewed from Northwest

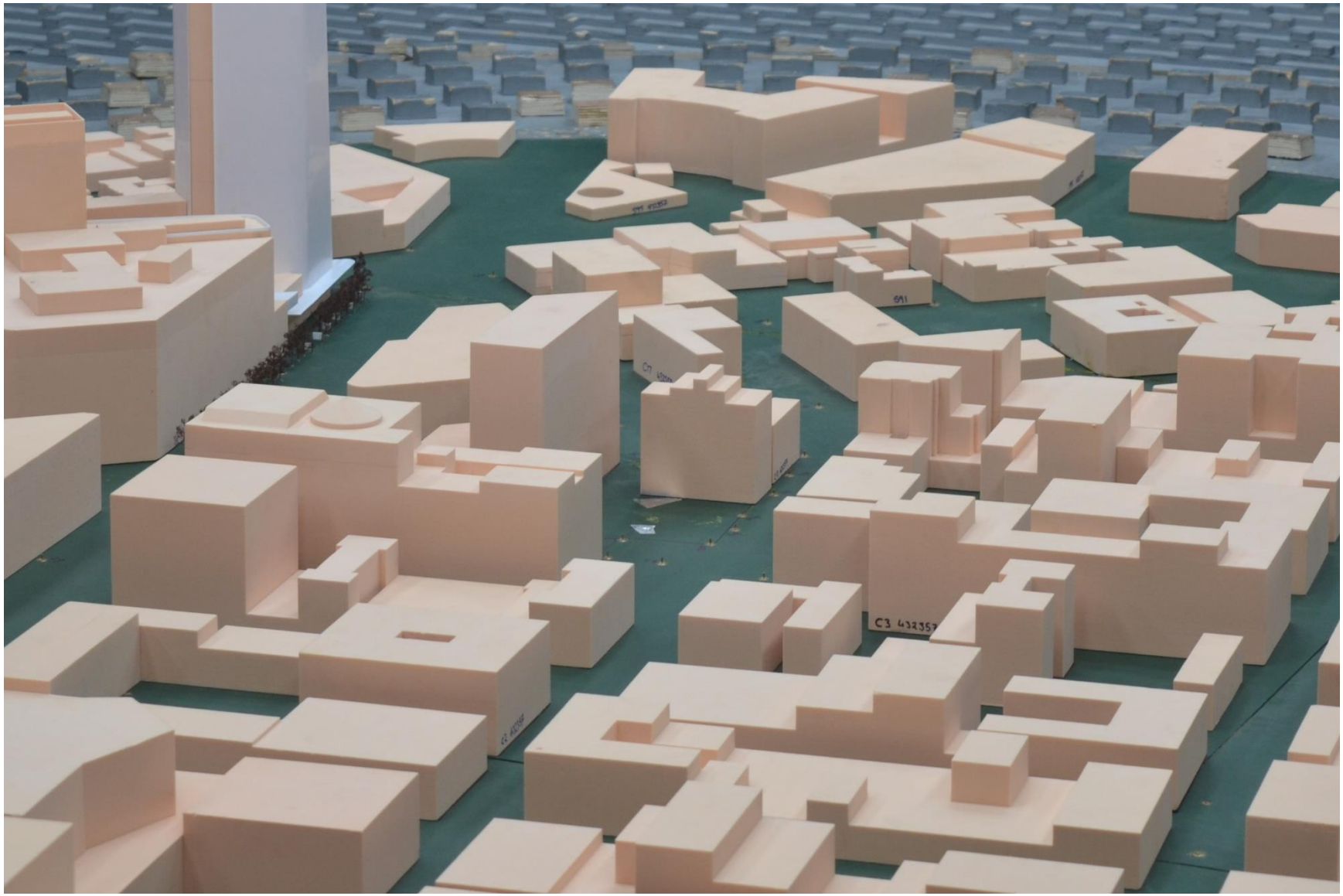


Figure D.2: Existing Scenario, Wind Tunnel Setup, Viewed from Southeast

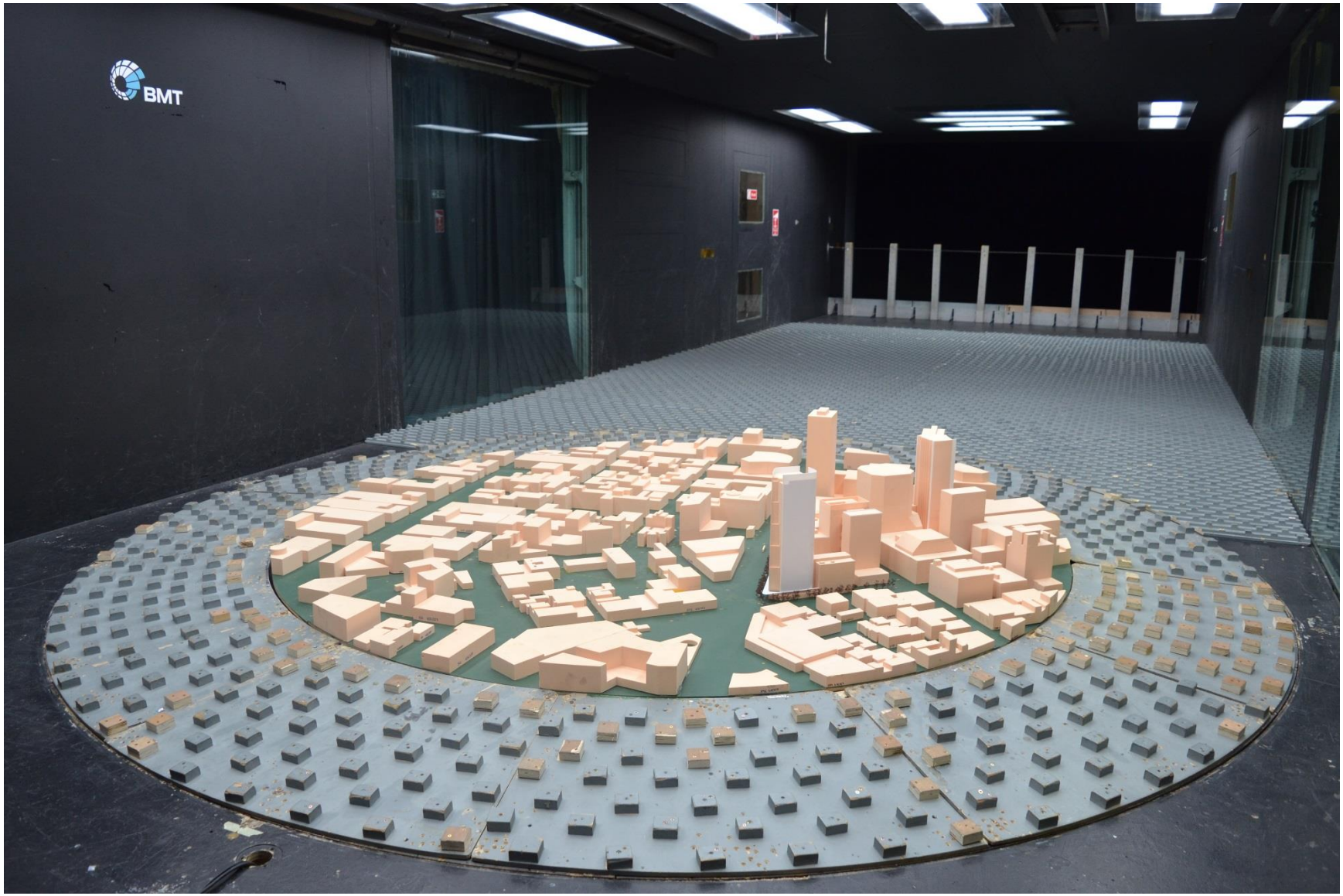


Figure D.3: Existing Plus Project Scenario (Close-up), Viewed from Northwest

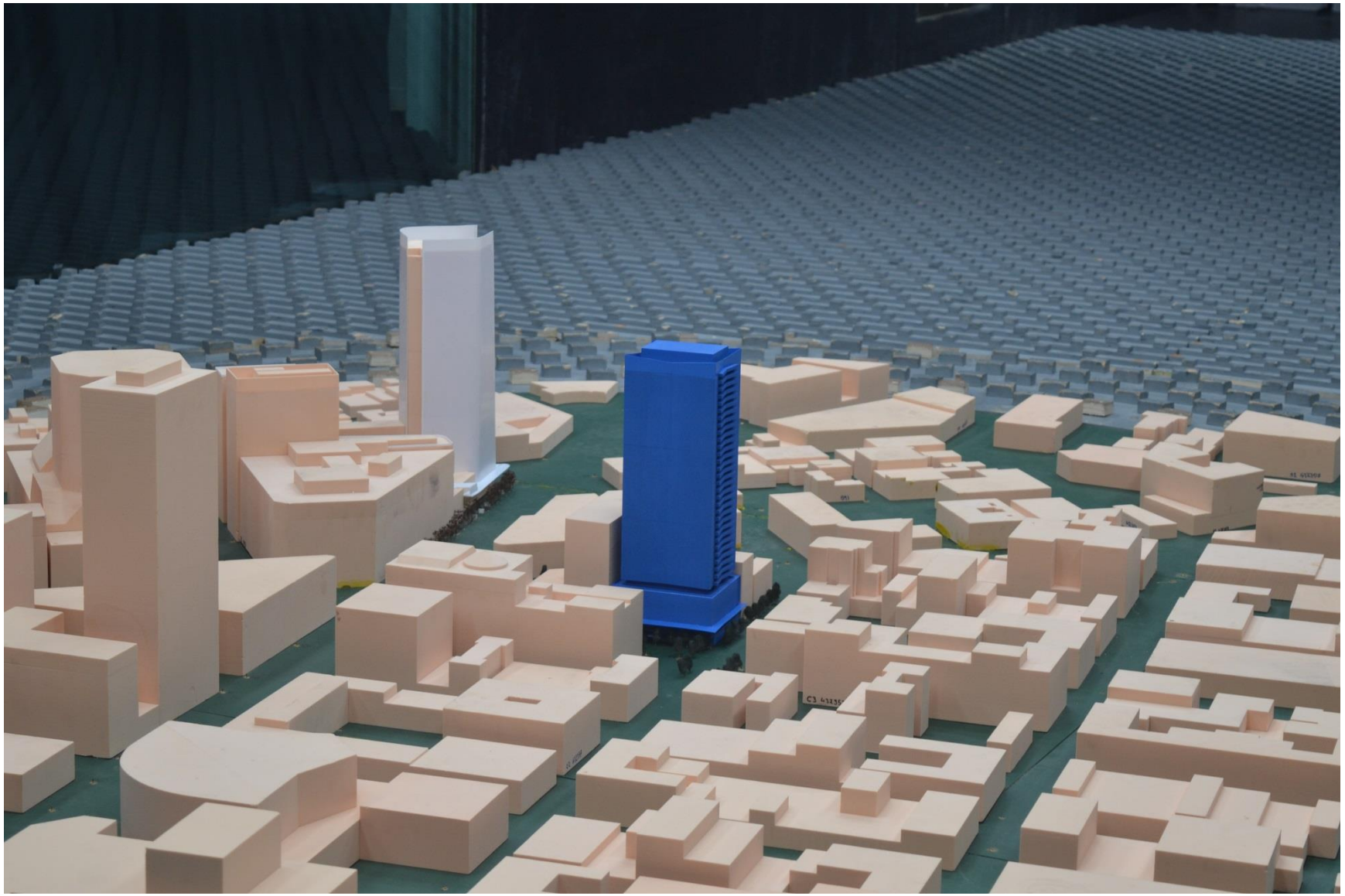


Figure D.4: Existing Plus Project Scenario, Viewed from Northeast

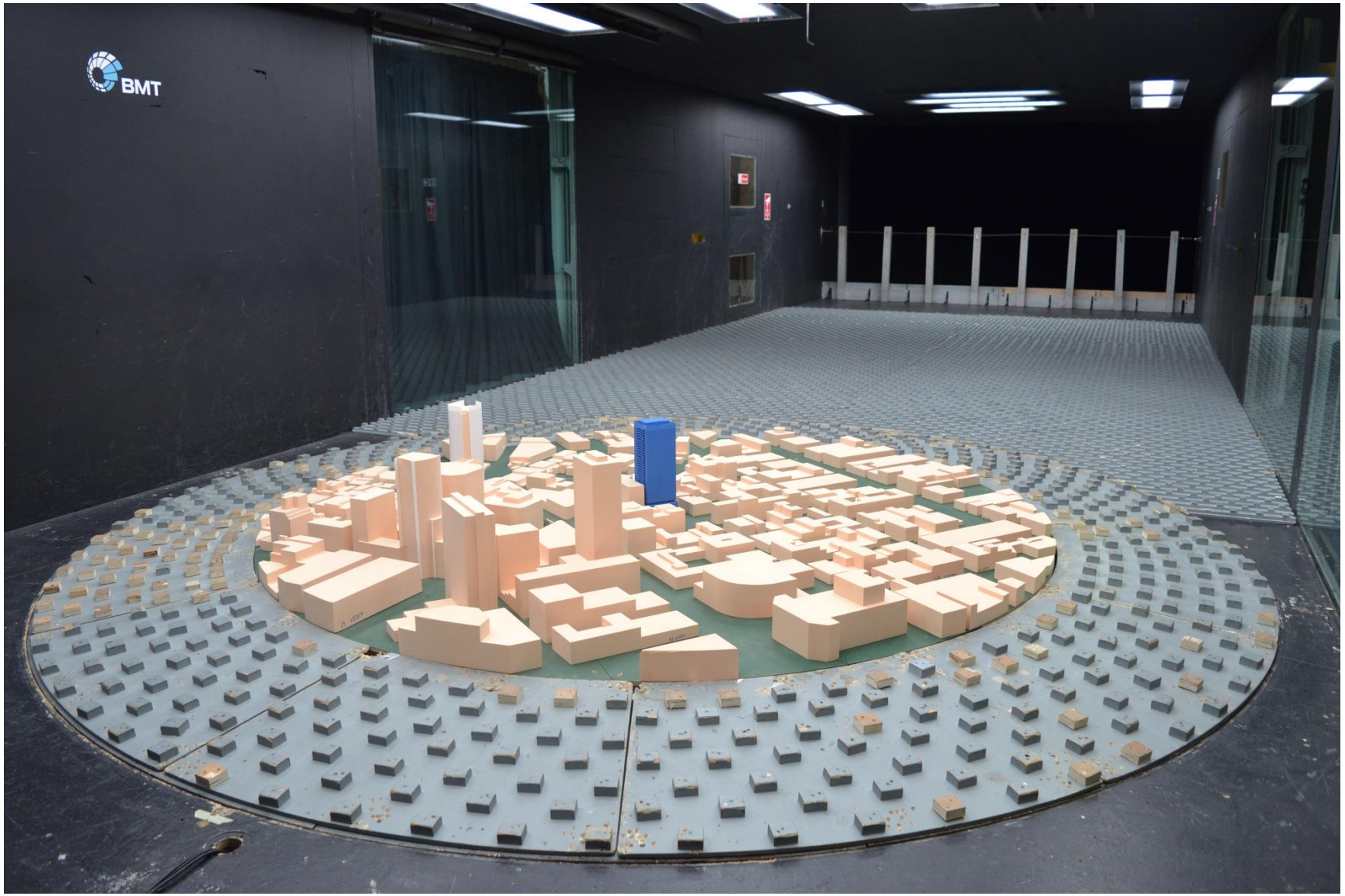
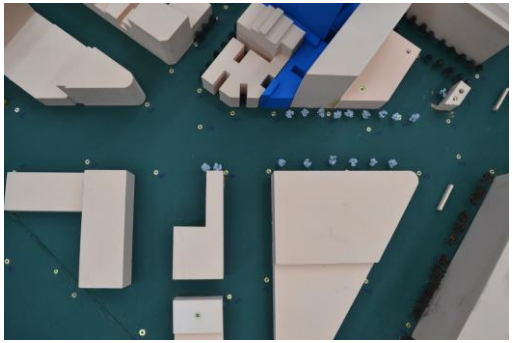
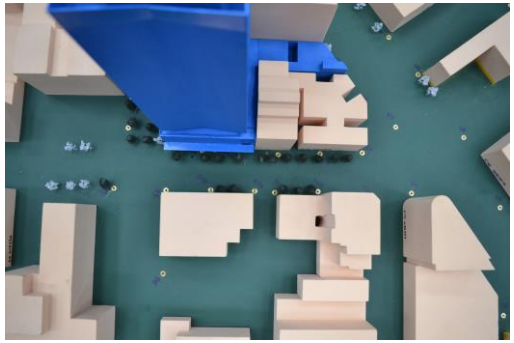
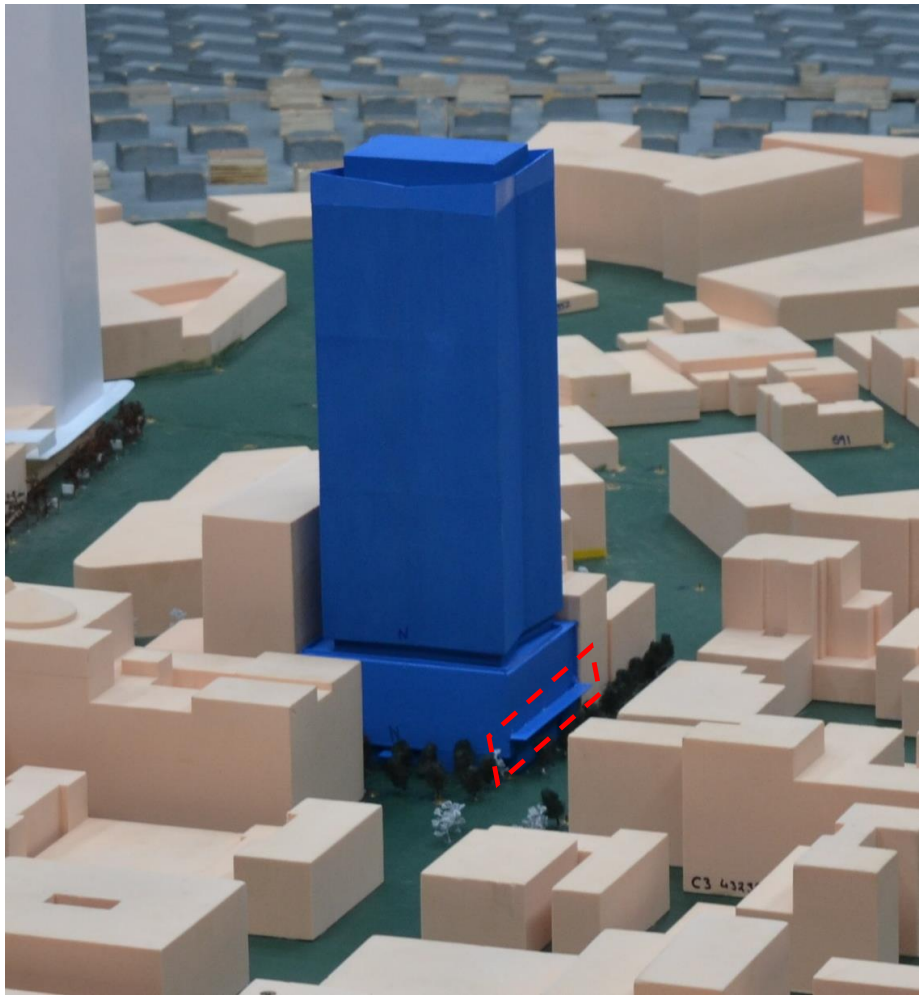


Figure D.5: Wind Mitigation Measures







Canopy Option 6b

432357 – 98 Franklin Wind Mitigation Measures	BMT	Drawing No: 432357/FIG -C.5	By: T. Syafizan Date: July 16th, 2018

Appendix E Measurements and Analysis

E.1. Physical Measurements

Wind speed measurements were made using so-called 'Irwin probes', capable of measuring fluctuating pressure differences that are calibrated against wind speed. All the probes were calibrated to an accuracy of within 2 percent before the test procedure was begun. A system of probes running simultaneously was used to obtain results from the 85 test points at a height corresponding to approximately 5 feet at full scale.

The wind velocity scale (ratio of model scale velocity to full scale velocity) of the wind tunnel test was 1/1, where the frequency scale (ratio of model scale frequency to full scale frequency) was 1/300. The freestream wind speed of the test was approximately 50mph. The data was sampled at a full-scale frequency of 5 samples per second at full scale which corresponds to 600Hz at model scale. Data were recorded for 49 seconds at model scale (245 minutes at full scale) for each wind direction to determine the mean and gust wind speeds. The turbulence intensity was derived based on the measured mean and standard deviation of the wind speeds.

The ratio between the measured wind speeds at a height of 5 feet above the surface level and the wind speed at the reference height, namely the "wind speed-up ratio", was derived from each of the Irwin measurement, at each wind direction. The wind speed- up ratios are usually less than 1, as the speed of the lowest part of an air mass is slowed down when the air moves across the buildings.

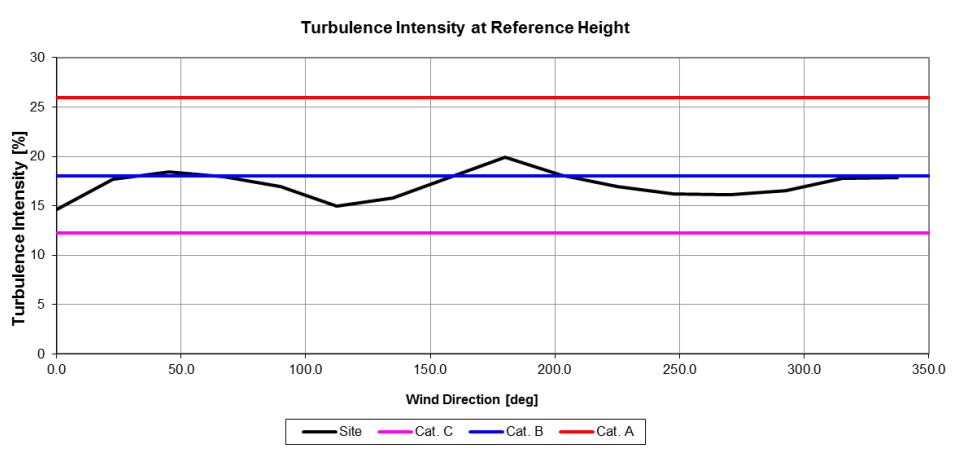
For each location, the wind speed-up ratio at each wind direction combines with the wind statistics measured in the old San Francisco Federal Building at 50 United Nations Plaza. The summation of the combined results of wind speed-up ratios and wind statistics for all wind directions are used to access the wind conditions in terms of the exceedance of threshold wind speeds that relate to hazard and comfort levels defined in the Planning Code Section 148.

E.2. Wind Properties at Project Site

A detailed wind analysis was carried out to determine the wind properties at the Proposed Project site. The wind analysis is based on the widely accepted Deaves and Harris log law wind model of the atmospheric boundary layer, as defined in ESDU (Engineering Sciences Data Unit) Item 01008 and has provided wind profiles describing the variation of wind speed and turbulence intensity with height for the wind directions on interest. From this analysis representative profiles were defined as targets for the atmospheric boundary layer simulation in the wind tunnel.

Figure E.1 shows the variation of longitudinal turbulence intensity with wind direction at the reference height of 384ft.

Figure E.1: Variation of Turbulence Intensity with Wind Direction at 384ft Height, Including Reference Turbulence Levels



Due to the variation of wind properties with wind direction, two target profiles have been selected for the boundary layer simulation.

The target profiles and range of wind angles for each wind tunnel profile are as follows:

Profile	Wind Angle Range	Target Angle
Fetch 1	0°, 90° to 135°, 225 to 292.5°	270°
Fetch 2	22.5° to 67.5°, 157.5° to 202.5°, 315° to	60°

Figures E.2a and **E.2b** present the variation of mean wind speed, longitudinal turbulence intensity and gust wind speed used in the tests. The wind speed profiles are normalized by the mean wind speed at the reference height of 384ft.

Figure E.2a: Mean Wind Speed ($U_{mean}/U_{mean(Ref)}$), Longitudinal Turbulence Intensity Profiles (I_u) and Gust Wind Speed ($U_{gust}/U_{mean(Ref)}$) Modelled in the Study (Exposure 1)

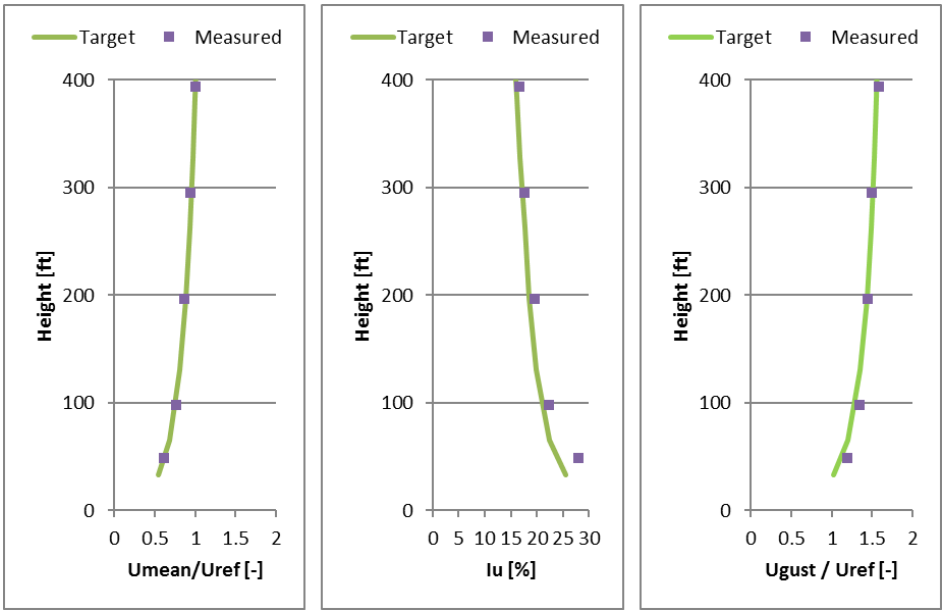
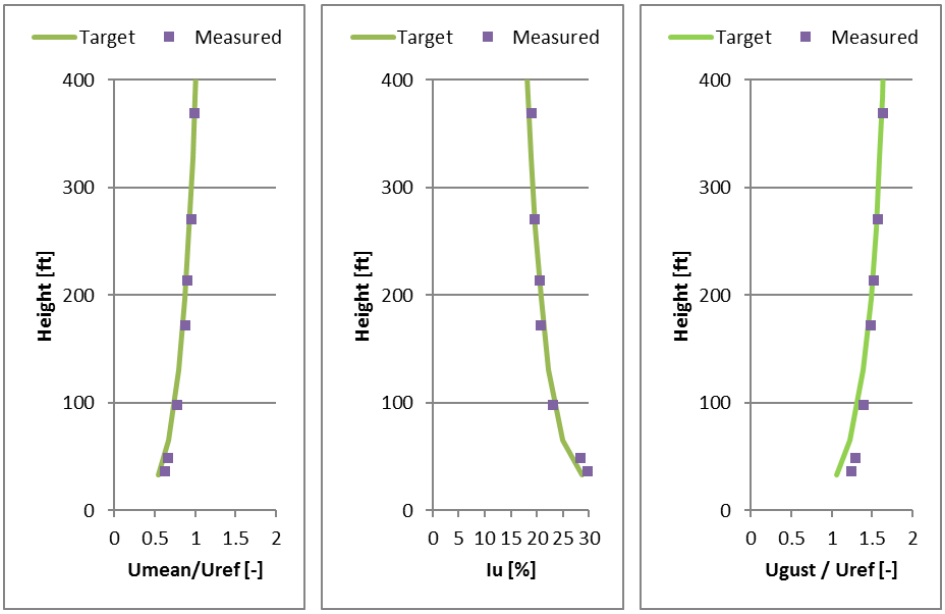
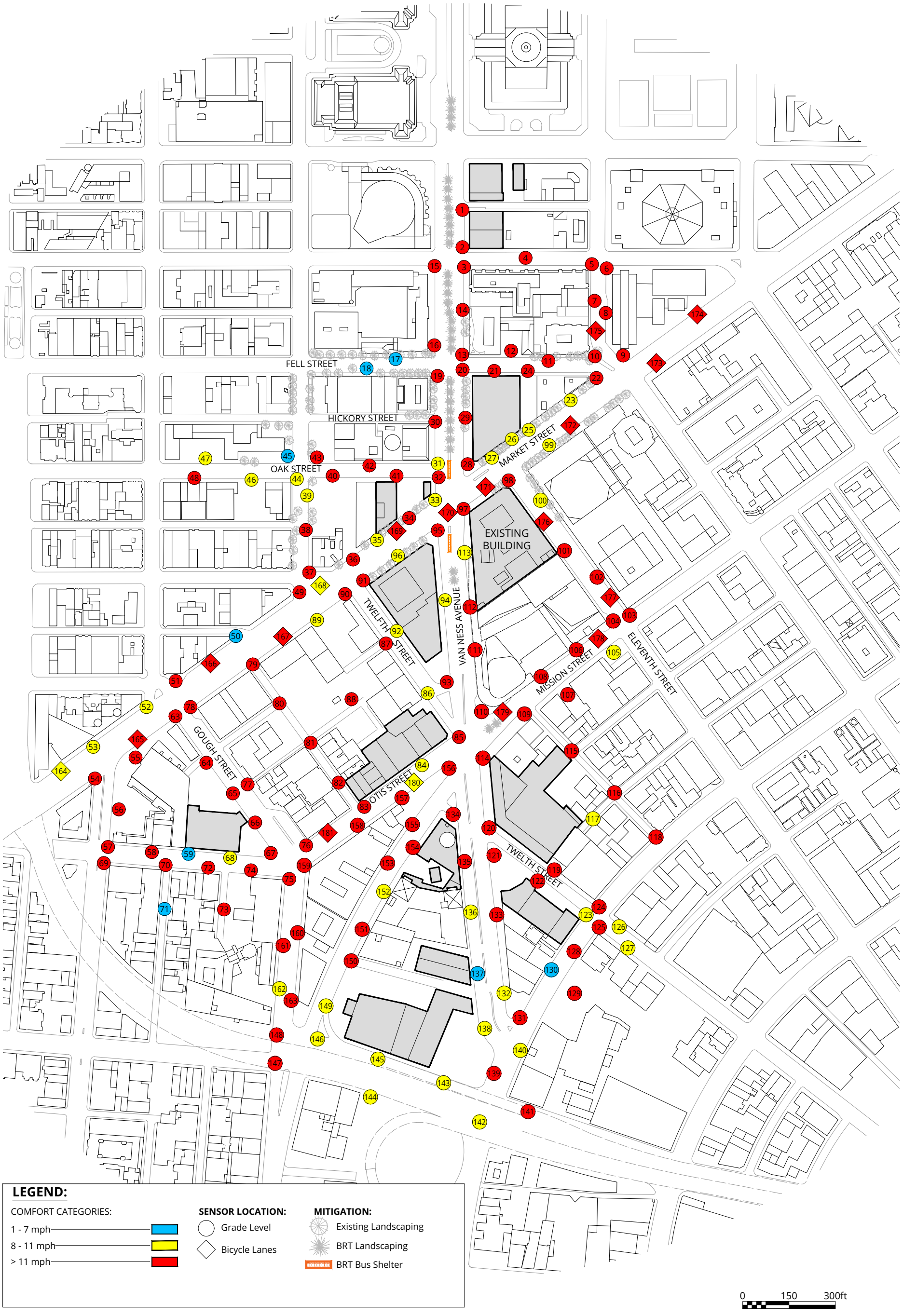


Figure E.2b: Mean Wind Speed ($U_{mean}/U_{mean(Ref)}$), Longitudinal Turbulence Intensity Profiles (I_u) and Gust Wind Speed ($U_{gust}/U_{mean(Ref)}$) Modelled in the Study (Exposure 2)





LEGEND:

COMFORT CATEGORIES:

SENSOR LOCATION:

MITIGATION:

Pedestrian Wind Comfort Conditions

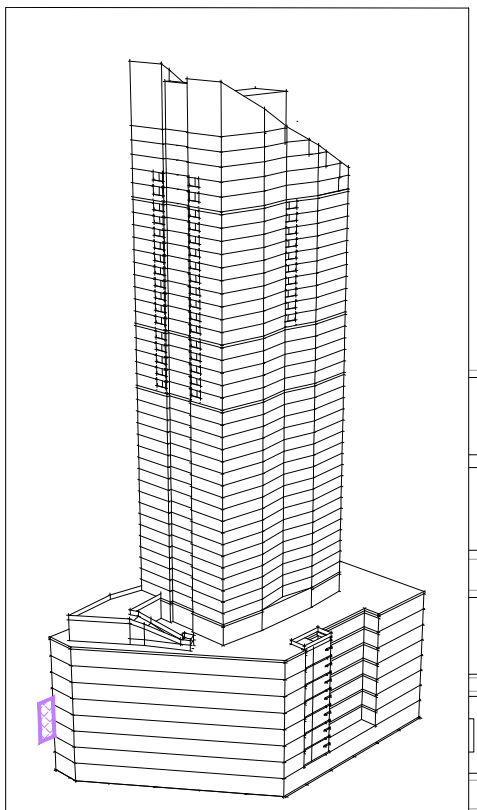
Existing
Annual

30 Van Ness - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 1a
Approx. Scale:	1"=300'
Date Revised:	Oct. 5, 2018



Isometric
Scale: 1"=200'

FELL STREET
HICKORY STREET
OAK STREET
MARKET STREET
EXISTING BUILDING
VAN NESS AVENUE
TWELFTH STREET
GOUGH STREET
OTIS STREET
MISSION STREET
ELEVENTH STREET
TWELTH STREET

LEGEND:

COMFORT CATEGORIES:
- 1 - 7 mph
- 8 - 11 mph
- > 11 mph

SENSOR LOCATION:
- Grade Level
- Bicycle Lanes

MITIGATION:
- Existing Landscaping
- BRT Landscaping
- Proposed Landscaping
- BRT Bus Shelter
- 15ft. Deep Solid Canopy
- 10ft. Deep Solid Canopy
- 10ft. Deep 40% Porous Canopy
- 40ft. Tall x 20ft. Deep 50% Porous Vertical Screen
- 20ft. Tall 50% Porous Architectural Feature

0 150 300ft

Pedestrian Wind Comfort Conditions

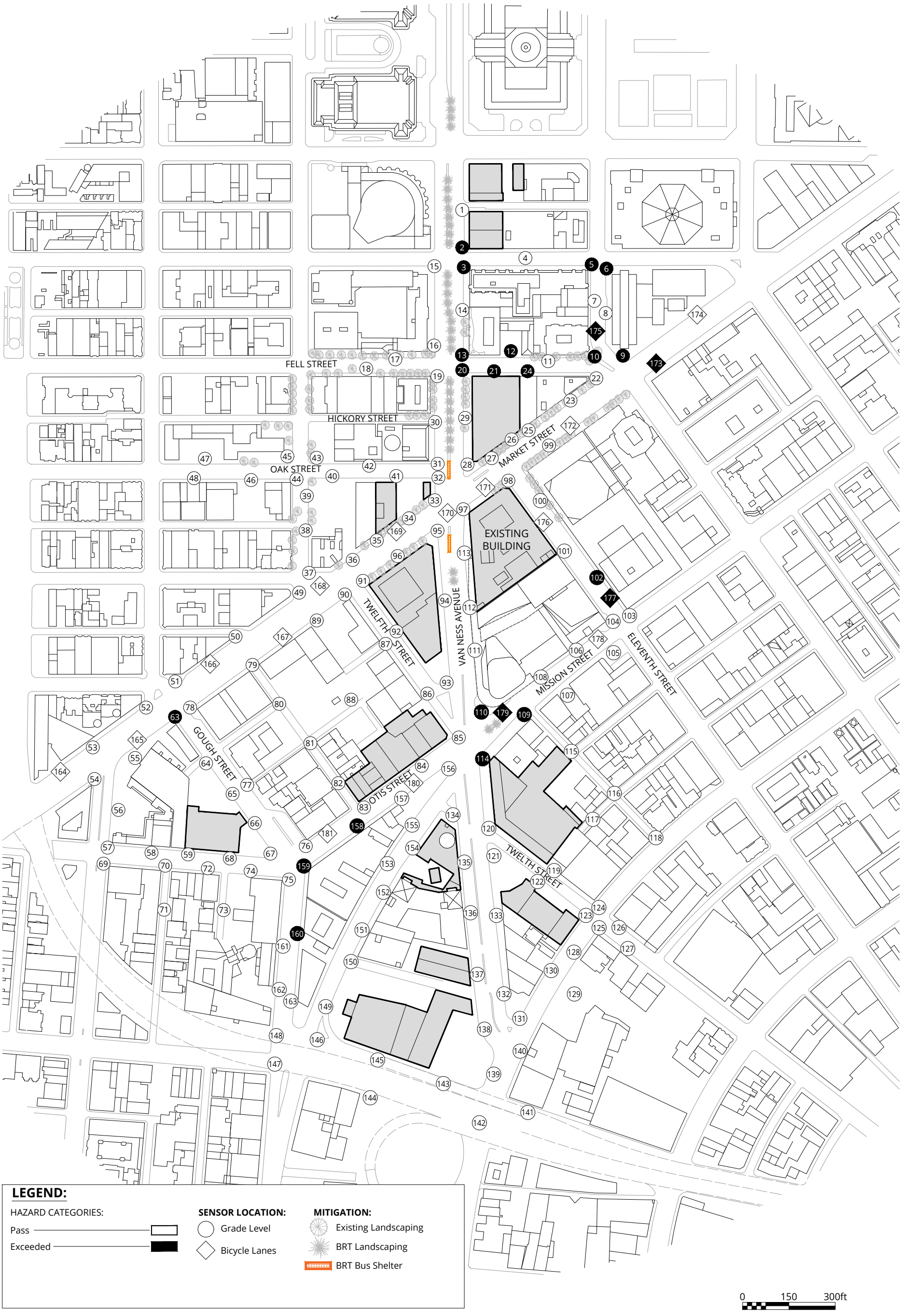
Existing + Project
Annual

30 Van Ness - San Francisco, CA

True North

Project #1701249

Drawn by: DBB	Figure: 1b
Approx. Scale:	1"=300'
Date Revised:	Dec. 11, 2018



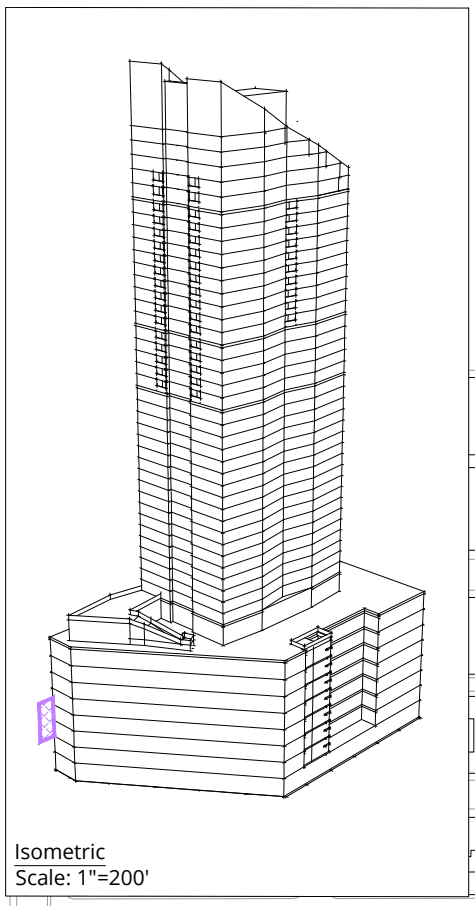
Pedestrian Wind Hazard Conditions
Existing
Annual

30 Van Ness - San Francisco, CA

True North

Project #1603628

Drawn by: DBB	Figure: 2a
Approx. Scale:	1"=300'
Date Revised:	Oct. 5, 2018



Isometric
Scale: 1"=200'

FELL STREET
HICKORY STREET
OAK STREET
MARKET STREET
VAN NESS AVENUE
TWELFTH STREET
GOUGH STREET
OTIS STREET
MISSION STREET
ELEVENTH STREET
TWELFTH STREET
EXISTING BUILDING

LEGEND:

HAZARD CATEGORIES:
- Pass
- Exceeded

SENSOR LOCATION:
- Grade Level
- Bicycle Lanes

MITIGATION:
- Existing Landscaping
- BRT Landscaping
- Proposed Landscaping
- BRT Bus Shelter
- 15ft. Deep Solid Canopy
- 10ft. Deep Solid Canopy
- 10ft. Deep 40% Porous Canopy
- 40ft. Tall x 20ft. Deep 50% Porous Vertical Screen
- 20ft. Tall 50% Porous Architectural Feature

0 150 300ft

Pedestrian Wind Hazard Conditions

Existing + Project
Annual

30 Van Ness - San Francisco, CA

True North

Project #1701249

Drawn by: DBB	Figure: 2b
Approx. Scale:	1"=300'
Date Revised:	Dec. 11, 2018

Table 1.1: Wind Comfort Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
1	15	28	e	19	41	4	e
2	21	47	e	22	49	1	e
3	22	47	e	24	51	2	e
4	17	35	e	19	45	2	e
5	19	42	e	19	41	0	e
6	18	35	e	22	51	4	e
7	12	16	e	13	18	1	e
8	14	22	e	15	26	1	e
9	25	50	e	25	49	0	e
10	23	51	e	23	51	0	e
11	15	28	e	15	25	0	e
12	22	49	e	13	19	-9	e
13	22	51	e	19	45	-3	e
14	12	18	e	11	10	-1	
15	16	29	e	16	28	0	e
16	12	15	e	11	10	-1	
17	7	1		8	1	1	
18	7	0		8	3	1	
19	15	28	e	14	22	-1	e
20	20	46	e	17	35	-3	e
21	26	60	e	20	46	-6	e
22	13	17	e	19	41	6	e
23	11	10		12	16	1	e
24	22	50	e	14	22	-8	e
25	8	2		14	22	6	e
26	8	2		11	10	3	
27	9	3		16	28	7	e
28	14	24	e	18	36	4	e
29	13	16	e	17	34	4	e
30	14	18	e	16	31	2	e
31	10	8		18	37	8	e
32	14	22	e	14	23	0	e
33	10	8		18	38	8	e
34	17	35	e	19	42	2	e
35	11	10		14	20	3	e
36	20	47	e	20	48	0	e
37	13	16	e	15	25	2	e
38	13	17	e	12	16	-1	e
39	10	7		10	5	0	
40	16	29	e	15	27	-1	e
41	17	33	e	18	37	1	e
42	14	22	e	15	26	1	e
43	14	19	e	14	18	0	e
44	8	1		9	4	1	
45	7	1		8	2	1	
46	9	3		11	10	2	
47	11	10		14	22	3	e

Table 1.1: Wind Comfort Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
48	13	18	e	12	15	-1	e
49	12	13	e	12	13	0	e
50	7	0		7	0	0	
51	13	18	e	12	12	-1	e
52	10	6		9	3	-1	
53	8	1		7	0	-1	
54	14	19	e	13	15	-1	e
55	13	20	e	23	52	10	e
56	14	22	e	13	18	-1	e
57	14	19	e	12	12	-2	e
58	14	23	e	13	19	-1	e
59	7	1		12	12	5	e
60	5	0		5	0	0	
61	5	0		5	0	0	
62	5	0		5	0	0	
63	22	49	e	21	47	-1	e
64	14	23	e	14	21	0	e
65	16	28	e	16	28	0	e
66	12	15	e	13	19	1	e
67	13	20	e	13	18	0	e
68	10	5		10	4	0	
69	15	29	e	14	25	-1	e
70	17	32	e	16	28	-1	e
71	6	0		6	0	0	
72	14	22	e	13	18	-1	e
73	16	28	e	15	26	-1	e
74	16	31	e	16	30	0	e
75	15	24	e	15	26	0	e
76	15	26	e	15	27	0	e
77	16	30	e	16	28	0	e
78	14	22	e	14	21	0	e
79	17	36	e	16	29	-1	e
80	12	13	e	14	24	2	e
81	13	19	e	13	19	0	e
82	16	30	e	16	30	0	e
83	15	25	e	15	26	0	e
84	10	7		11	10	1	
85	13	20	e	14	22	1	e
86	11	10		12	13	1	e
87	12	15	e	11	10	-1	
88	12	14	e	13	19	1	e
89	11	10		13	19	2	e
90	12	15	e	12	13	0	e
91	12	13	e	11	10	-1	
92	9	5		10	5	1	
93	14	21	e	14	22	0	e
94	11	10		14	21	3	e

Table 1.1: Wind Comfort Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
95	13	20	e	13	21	0	e
96	10	8		12	13	2	e
97	14	24	e	20	42	6	e
98	14	24	e	16	28	2	e
99	10	8		11	10	1	
100	9	3		13	16	4	e
101	15	26	e	16	30	1	e
102	21	48	e	22	48	1	e
103	17	34	e	17	32	0	e
104	16	32	e	19	37	3	e
105	11	10		11	10	0	
106	13	17	e	12	15	-1	e
107	15	24	e	14	21	-1	e
108	16	31	e	16	29	0	e
109	25	57	e	25	58	0	e
110	21	48	e	21	49	0	e
111	13	19	e	12	15	-1	e
112	13	18	e	15	26	2	e
113	11	10		13	21	2	e
114	19	39	e	19	41	0	e
115	14	23	e	15	27	1	e
116	13	19	e	12	13	-1	e
117	11	10		11	10	0	
118	14	23	e	14	23	0	e
119	14	24	e	14	21	0	e
120	17	38	e	16	32	-1	e
121	15	26	e	14	23	-1	e
122	13	19	e	12	13	-1	e
123	11	10		11	10	0	
124	15	24	e	14	22	-1	e
125	14	21	e	13	20	-1	e
126	11	10		12	13	1	e
127	11	10		11	10	0	
128	12	12	e	12	12	0	e
129	13	18	e	13	18	0	e
130	7	0		7	0	0	
131	12	15	e	12	17	0	e
132	10	6		10	5	0	
133	16	30	e	16	31	0	e
134	15	27	e	14	24	-1	e
135	12	13	e	13	15	1	e
136	8	1		8	1	0	
137	6	0		6	0	0	
138	11	10		12	13	1	e
139	13	18	e	13	17	0	e
140	11	10		11	10	0	
141	12	14	e	12	14	0	e

Table 1.1: Wind Comfort Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
142	10	7		10	7	0	
143	11	10		12	14	1	e
144	9	2		9	2	0	
145	8	1		8	1	0	
146	11	10		11	10	0	
147	13	15	e	14	21	1	e
148	12	13	e	12	15	0	e
149	10	5		10	5	0	
150	13	20	e	13	19	0	e
151	15	24	e	15	24	0	e
152	10	7		10	6	0	
153	14	23	e	14	24	0	e
154	13	19	e	13	19	0	e
155	12	14	e	13	17	1	e
156	12	14	e	13	19	1	e
157	15	27	e	16	30	1	e
158	17	32	e	18	34	1	e
159	17	31	e	17	32	0	e
160	17	34	e	18	35	1	e
161	14	21	e	14	22	0	e
162	11	10		12	12	1	e
163	13	16	e	14	17	1	e

SUMMARY	Average (mph)	Average (%)	Total	Average (mph)	Average (%)	Speed Change (mph)	Total
	13	**20**	**112 ---- 163**	**14**	**21**	**1**	**126 ---- 163**

Table 2.1: Wind Hazard Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
1	28	0		31	0	0	
2	38	3	e	39	5	2	e
3	38	12	e	40	22	10	e
4	31	0		31	0	0	
5	42	20	e	40	9	-11	e
6	41	11	e	38	3	-8	e
7	22	0		23	0	0	
8	25	0		30	0	0	
9	43	60	e	42	40	-20	e
10	44	29	e	42	19	-10	e
11	29	0		28	0	0	
12	40	13	e	26	0	-13	
13	42	20	e	38	3	-17	e
14	22	0		21	0	0	
15	29	0		29	0	0	
16	23	0		20	0	0	
17	14	0		15	0	0	
18	13	0		17	0	0	
19	29	0		26	0	0	
20	38	3	e	33	0	-3	
21	52	144	e	38	2	-142	e
22	28	0		42	18	18	e
23	23	0		26	0	0	
24	47	47	e	30	0	-47	
25	17	0		29	0	0	
26	17	0		24	0	0	
27	18	0		35	0	0	
28	30	0		35	0	0	
29	28	0		34	0	0	
30	31	0		29	0	0	
31	21	0		30	0	0	
32	26	0		29	0	0	
33	19	0		35	0	0	
34	31	0		35	0	0	
35	22	0		24	0	0	
36	35	0		35	0	0	
37	31	0		30	0	0	
38	25	0		23	0	0	
39	19	0		18	0	0	
40	29	0		30	0	0	
41	35	0		38	3	3	e
42	25	0		26	0	0	
43	29	0		32	0	0	
44	14	0		15	0	0	
45	15	0		15	0	0	
46	18	0		17	0	0	
47	22	0		22	0	0	

Table 2.1: Wind Hazard Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
48	28	0		27	0	0	
49	28	0		29	0	0	
50	13	0		15	0	0	
51	23	0		22	0	0	
52	19	0		18	0	0	
53	15	0		15	0	0	
54	28	0		27	0	0	
55	25	0		24	0	0	
56	29	0		29	0	0	
57	29	0		28	0	0	
58	27	0		26	0	0	
59	15	0		15	0	0	
60	-	-	-	-	-	-	-
61	-	-	-	-	-	-	-
62	-	-	-	-	-	-	-
63	42	20	e	42	19	-1	e
64	27	0		26	0	0	
65	26	0		26	0	0	
66	23	0		22	0	0	
67	26	0		25	0	0	
68	20	0		20	0	0	
69	30	0		29	0	0	
70	35	0		34	0	0	
71	12	0		12	0	0	
72	30	0		29	0	0	
73	29	0		29	0	0	
74	29	0		28	0	0	
75	31	0		29	0	0	
76	28	0		27	0	0	
77	29	0		28	0	0	
78	26	0		25	0	0	
79	29	0		29	0	0	
80	26	0		25	0	0	
81	25	0		24	0	0	
82	28	0		27	0	0	
83	28	0		30	0	0	
84	24	0		26	0	0	
85	25	0		26	0	0	
86	22	0		22	0	0	
87	20	0		20	0	0	
88	22	0		21	0	0	
89	21	0		21	0	0	
90	22	0		19	0	0	
91	21	0		18	0	0	
92	19	0		18	0	0	
93	27	0		26	0	0	
94	22	0		28	0	0	

Table 2.1: Wind Hazard Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
95	24	0		25	0	0	
96	22	0		27	0	0	
97	28	0		42	20	20	e
98	26	0		32	0	0	
99	22	0		21	0	0	
100	17	0		27	0	0	
101	29	0		27	0	0	
102	37	1	e	41	17	16	e
103	30	0		29	0	0	
104	31	0		34	0	0	
105	23	0		24	0	0	
106	23	0		21	0	0	
107	25	0		24	0	0	
108	31	0		31	0	0	
109	48	80	e	51	102	22	e
110	43	22	e	43	25	3	e
111	24	0		23	0	0	
112	25	0		29	0	0	
113	18	0		24	0	0	
114	37	4	e	39	5	1	e
115	25	0		27	0	0	
116	23	0		23	0	0	
117	20	0		21	0	0	
118	26	0		27	0	0	
119	26	0		25	0	0	
120	31	0		30	0	0	
121	27	0		26	0	0	
122	23	0		21	0	0	
123	22	0		22	0	0	
124	26	0		25	0	0	
125	27	0		26	0	0	
126	21	0		20	0	0	
127	21	0		21	0	0	
128	22	0		21	0	0	
129	22	0		22	0	0	
130	12	0		12	0	0	
131	22	0		22	0	0	
132	18	0		18	0	0	
133	33	0		32	0	0	
134	29	0		28	0	0	
135	24	0		23	0	0	
136	15	0		14	0	0	
137	11	0		11	0	0	
138	21	0		21	0	0	
139	24	0		25	0	0	
140	21	0		21	0	0	
141	24	0		23	0	0	

Table 2.1: Wind Hazard Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
142	19	0		20	0	0	
143	25	0		23	0	0	
144	17	0		17	0	0	
145	13	0		13	0	0	
146	19	0		18	0	0	
147	22	0		21	0	0	
148	21	0		20	0	0	
149	19	0		18	0	0	
150	25	0		24	0	0	
151	32	0		31	0	0	
152	19	0		19	0	0	
153	28	0		28	0	0	
154	24	0		24	0	0	
155	22	0		22	0	0	
156	26	0		28	0	0	
157	31	0		31	0	0	
158	41	14	e	40	7	-7	e
159	36	1	e	36	1	-1	e
160	39	4	e	37	2	-2	e
161	25	0		25	0	0	
162	23	0		23	0	0	
163	30	0		29	0	0	

SUMMARY	Average (mph)	Total Hours	Total	Average (mph)	Total Hours	Hours Change	Total
	26	**508**	**19 ---- 160**	**26**	**322**	**-186**	**19 ---- 160**

APPENDIX G-2
170 OTIS STREET DESIGN CHANGE WIND MEMORANDUM

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Canada

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Fax: +1.519.823.1316

May 21, 2019

San Francisco Planning Department
Attention: Alana Callagy,
Environmental Planning Division

c/o Erin Efner
ICF International
Erin.Efner@icf.com

Re: Market/Octavia Hub Plan
RWDI Project 1602253

Dear Erin,

As per your request, Rowan Williams Davies & Irwin Inc. (RWDI) has prepared this letter to discuss the effect of the proposed change in height of the 170 Otis Street site.

RWDI carried out a wind tunnel study in 2018, final report submitted January 18, 2019 to assess the expected wind conditions in the Market/ Octavia Area Hub Plan. Upon completion of wind tunnel testing, an additional site was added to the Hub Plan project at 170 Otis Street. The 170 Otis Street site currently contains an existing office building (approximately 85 to 125 ft) split between 85-X and 125-X height and bulk zoning districts. The sponsor proposes updating the zoning map to reflect the existing footprint of the building, which would result in shifting 85-X and 125-X height and bulk zoning districts, adding a 45-X height and bulk zoning district, and rezoning the site to allow raising the taller portion (i.e., the location where the existing building is 110 to 125 feet) to a 150-X height and bulk zoning district.

The 170 Otis site is located downwind of the 33 Gough Street site. For this reason, the 170 Otis Street massing would be sheltered from the prevalent winds by the 33 Gough Street development evaluated in the 2018 wind tunnel study. Therefore, in the presence of the 33 Gough Street development, wind conditions around 170 Otis Street would not be affected by the proposed changes to the zoning map or increasing certain locations to up to 150 feet tall, as described above. For these reasons it is unlikely that there would be new exceedances of the comfort or hazard criteria that were not already identified in the previously conducted wind tunnel test.

Yours truly,

Raisa Lalui, M.Eng
Technical Coordinator

Dan Bacon
Senior Project Manager / Associate

APPENDIX G-3
MARKET/OCTAVIA HUB PLAN MEMORANDUM

600 Southgate Drive
Guelph, ON N1G 4P6
Canada

Tel: +1.519.823.1311
Fax: +1.519.823.1316

June 3, 2019

San Francisco Planning Department
Attention: Alana Callagy,
Environmental Planning Division

c/o Erin Efner
ICF International
Erin.Efner@icf.com

Re: Market/Octavia Hub Plan
RWDI Project 1602253

Dear Erin,

As per your request, this memo discusses potential wind impacts of buildings under 85 feet in height in the Hub area.

It is well understood that wind speeds increase with elevations above ground. Buildings taller than their surroundings would intercept winds at higher elevations and deflect them down to the ground level. This is the main cause for increased ground-level wind activity around tall buildings.

In the Hub area, except for some tall buildings along Market Street and Van Ness Ave, most buildings are 3 to 5 stories, in the range of 30 to 60 feet in height, as shown in the photographs below.

Google Earth Photo (left) and Wind Tunnel Model (right) for the Hub Area

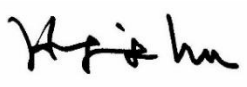
A new building at 85 feet or lower in the area would be the same as or slightly taller than the existing surroundings and would have limited wind exposure. Therefore, the potential increase in wind speeds would not be substantial. Based on our extensive experience with wind tunnel tests of buildings in the area, it would be unlikely for buildings lower than 85 feet to create hazard exceedances (wind speeds

that exceed 26 mph for more than one hour per year) and, hence, no wind mitigation measures would typically be required.

Closing

We trust this memo satisfies your current needs. If you have additional questions, please do not hesitate to contact us.

Yours truly,



Hanqing Wu, Ph.D., P.Eng.
Senior Technical Director / Principal

Dan Bacon
Senior Project Manager / Associate

APPENDIX G-4
30 VAN NESS AVENUE WIND STUDY

DRAFT REPORT

30 VAN NESS

SAN FRANCISCO, CA

PEDESTRIAN WIND STUDY

RWDI #1701249

March 12, 2019

SUBMITTED TO

Alana Callagy
Senior Planner
Alana.Callagy@sfgov.org

Environmental Planning Division
San Francisco Planning Department
1650 Mission Street, Suite 400
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SUBMITTED BY

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EXECUTIVE SUMMARY

The wind conditions around the proposed 30 Van Ness development are discussed in detail within the content of this report and are summarized as follows:

- Existing wind speeds around the project site average 13.4 mph across all measurement locations for comfort conditions. With the addition of the proposed development a slight increase in wind speeds (to an average of 13.7 mph) is expected around the proposed development, compared to the Existing configuration.
- In the Existing configuration, winds at 19 locations exceed the wind hazard criterion for a total of 508 hours. With the addition of the proposed project, these conditions are predicted to be similar, with wind speeds exceeding the wind hazard criterion at 19 locations (though three of the 19 locations differ from those under the Existing configuration) for a total of 322 hours.

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1 INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by Lendlease to assess and consult on the pedestrian wind conditions on and around the proposed 30 Van Ness (Project) in San Francisco, CA. The Project site, as shown in **Image 1**, is located at the northeast corner of the intersection of Van Ness Avenue and Market Street.

The purpose of the study is to assess the wind environment around the Project in terms of pedestrian comfort and hazard. The quantitative assessment was based on wind speed measurements on a scale model of the Project and its surroundings in a boundary-layer wind tunnel. The assessment focused on critical pedestrian areas including pedestrian accessible areas on-site, adjacent residential properties, and sidewalks along nearby streets. Bike routes, although not pedestrian areas, were assessed for informational purposes.

RWDI has conducted a series of wind tunnel tests with various forms of massing and landscaping changes to the proposed Project to meet the City of San Francisco Planning Code Section 148 wind criteria. The results presented along with this report pertain to the design option with design features that currently comply with Planning Code Section 148 wind criteria. These results are based on the wind tunnel tests conducted on a design option with a podium height of 120 feet.

This report summarizes the methodology of wind tunnel studies for pedestrian wind conditions, describes the San Francisco pedestrian wind criteria and presents the local wind conditions and their effects on pedestrians.

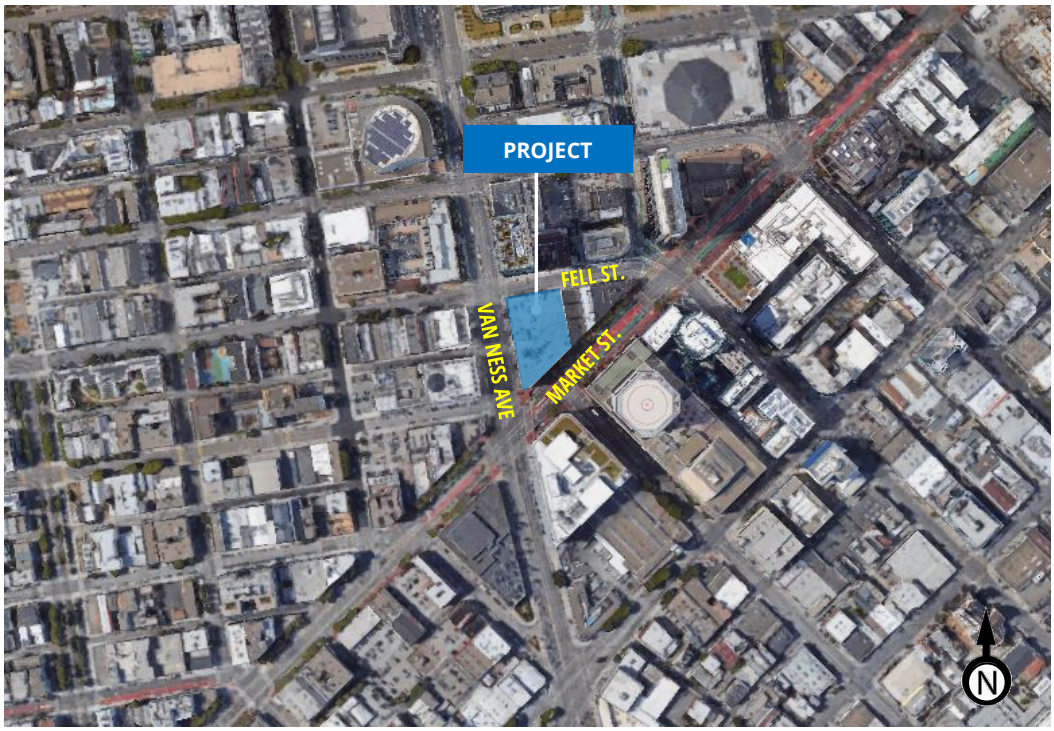


Image 1: Site plan – Aerial view of site and surroundings (courtesy of Google™ Earth)

2 METHODOLOGY

2.1 Test Configurations

In order to assess the wind environment around the proposed Project, a 1:400 scale model of the project site and surroundings was constructed for the wind tunnel tests and the following configurations were tested:

Existing:	all existing buildings on-site and in the surroundings including buildings/developments under construction, with Van Ness Avenue Bus Rapid Transit (BRT) trees and station structures and existing landscaping on and around the project site (**Image 2a**); and,
Existing + Project:	the proposed 30 Van Ness Project with wind reduction measures as specified in **Figures 1b and 2b** added to the Existing surroundings (**Image 2b**).

The scale model of the proposed Project (as shown in **Image 2b**) was constructed using the design information and drawings listed in **Appendix A**. The wind tunnel model included all relevant surrounding buildings and topography within a 3200 ft (0.6 mile) radius of the study site. It should be noted that the 30 Van Ness project was tested using the same area as Market/ Octavia Hub proximity model, as both projects contain the same approved existing surroundings for Market/ Octavia The Hub Plan project, as shown in the report "*Market/ Octavia Hub Plan – San Francisco, CA – Pedestrian Wind Study, RWDI Project 1603628*" issued on January 18, 2019. The results presented in this report are from wind tunnel testing conducted on November 26, 2018. The Cumulative analysis with future developments around the project site was run as part of the Hub Plan wind study by RWDI. The results of the Cumulative scenario wind conditions are contained in the "*Market/ Octavia Hub Plan – San Francisco, CA – Pedestrian Wind Study, RWDI Project 1603628*" issued on January 18, 2019. The boundary-layer wind conditions beyond the modelled area were simulated in RWDI's wind tunnel. The wind tunnel model was instrumented with 181 wind speed sensors to measure mean and gust wind speeds at a full-scale height of approximately 5 ft. The placement of wind measurement locations was based on our experience and understanding of the pedestrian usage for this site, and was reviewed by the San Francisco Planning Department, as part of the Hub Plan EIR process. These measurement data were generated for 16 equally incremented wind directions (in increments of 22.5 degrees).

Image 2a: Wind tunnel study model - Existing configuration


Image 2b: Wind tunnel study model – Existing + Proposed configuration

2.2 Local Climate

Data of wind speeds and directions, gathered at the old San Francisco Federal Building at 50 United Nations Plaza (at a height of 132 ft.) during the six-year period from 1945 to 1950, inclusive, have been used in this study. These data have been used historically for projects San Francisco.

Average wind speeds in San Francisco are highest in the summer and lowest in winter. However, the strongest peak winds occur in winter. Throughout the year the highest wind speeds occur in mid-afternoon and the lowest in the early morning. Westerly to northwesterly winds are the most frequent and strongest winds during all seasons. Of the primary wind directions, four have the greatest frequency of occurrence and make up the majority of the strong winds that occur. These winds include the northwest, west-northwest, west and west-southwest.

2.3 Planning Code Requirements

The project site is located in the Commercial District (C-3-0), which is subject to wind regulations of the Planning Code. Therefore, the criteria established in Planning Code Section 148 Reduction of Ground-Level Wind Currents in C-3 Districts (Appendix B) are used to analyze the proposed project's wind impacts.

Specifically, the Planning Code requires buildings to be shaped so as not to cause ground-level wind currents to exceed defined comfort and hazard criteria. The comfort criteria specify that wind speeds will not exceed, more than 10% of the time year-round, the comfort level of 11 miles per hour (mph) equivalent in substantial pedestrian use areas, and 7 mph equivalent in public seating areas between 7:00 am and 6:00 pm. Similarly, the hazard criterion of the Code requires that buildings not cause equivalent wind speeds to reach or exceed the hazard level of 26 mph for a single hour of the year.

The Planning Code defines the wind speeds in terms of equivalent wind speeds, and average wind speeds (mean velocity), adjusted to include the level of gustiness and turbulence. The equivalent wind speeds were calculated according to the specifications in the San Francisco Planning Code Section 243(c) (15), whereby the mean hourly wind speed is increased when the turbulence intensity is greater than 15% according to the following formula:

$$\boldsymbol{EWS} = \boldsymbol{V_m} \times (\mathbf{2} \times \boldsymbol{TI} + \mathbf{0.7})$$

Where: $\boldsymbol{EWS}$ = equivalent wind speed

$\boldsymbol{V_m}$ = mean pedestrian – level wind speed

$\boldsymbol{TI}$ = turbulence intensity

Note that the threshold wind speeds in the Planning Code were established by assuming wind speeds were all averaged for one hour, while the local wind data available from the old San Francisco Federal Building at 50 United Nations Plaza were recorded for a minute on each hour. Such a discrepancy has a more significant impact on strong winds that are related to hazardous conditions. Therefore, an equivalent wind speed of 36 mph (based on the actual one-minute averaged meteorological data), instead of the code value of 26 mph (based on the assumed one-hour averaged meteorological data), is commonly used in San Francisco for the assessment of hazardous winds.

It should be noted that at the request of the Planning Department, mean wind speeds were measured on bike lanes near this project for informational purposes only.

3 TEST RESULTS

This section presents the results of the wind tunnel measurements analyzed in terms of equivalent wind speeds as defined by the equation in Section 2.3. The text in the report simply refers to the data as wind speeds. A total of 181 test locations were included in the assessment. Of these, Locations 1 through 163 are on pedestrian areas such as sidewalks and Locations 164 through 181 are on the bike lanes along Market Street, Mission Street, 11th Street and Polk Street. There are 3 measurement locations that were initially instrumented but later were covered by an existing surrounding building due to a model update (Locations 60 through 62 in **Figures 1a through 1b**). Therefore, wind data for these three locations are not available. Given the existing windy conditions in the project area based on the initial wind tunnel tests conducted for 30 Van Ness, existing trees on and around the project site were subsequently included to represent the current wind conditions more accurately.

Figures 1a and 1b depict the Existing and Existing + Project wind comfort conditions respectively, while **Figures 2a and 2b** depict the relevant wind hazard conditions. The bike lane test locations are shown in **Figure 3**.

Table 1, located in the tables section**,** presents the wind comfort results for the two configurations tested. For each measurement point, the measured 10% exceeded (90th percentile) equivalent wind speed and the percentage of time that the wind speed would exceed 11 mph are listed for areas considered to be used primarily for walking. The point is marked as a comfort exceedance if the 11-mph threshold is exceeded. A letter “e” in the last column of each configuration indicates a wind comfort exceedance.

Table 2, presents the wind hazard results, and lists the predicted wind speeds that would be exceeded one hour per year at each of the grade level pedestrian sensors. The predicted number of hours per year that the Section 148 wind hazard criterion (one-minute wind speed of 36 mph) would be exceeded is also provided. A letter "e" in the last column of each configuration indicates a wind hazard exceedance.

Table 3, indicates the mean wind speeds for the bike lane areas.

3.1 Wind Comfort Conditions (Locations 1 through 163)

For the Existing configuration, wind speeds exceed 11 mph at most of the areas, averaging 13.4 mph across all measurement locations. Winds at 112 out of 160 test locations exceed the 11mph criterion (**Figure 1a and Table 1**). Wind speeds below 11 mph are predicted at a few isolated locations off-site.

With the addition of the proposed project, a net increase (0.3 mph) in wind speeds is expected during the Project configuration, compared to the Existing configuration. The average wind speed is predicted to be 13.7 mph, with 116 locations where wind speeds are predicted to exceed 11mph compared to 112 in the Existing configuration (**Figure 1b and Table 1**).

3.2 Wind Hazard Conditions (Locations 1 through 163)

Winds at 19 locations exceed the hazard criterion in the Existing configuration (Locations 2, 3, 5, 6, 9, 10, 12, 13, 20, 21, 24, 63, 102, 109, 110, 114 and 158-160 in **Figure 2a and Table 2**) for a total of 508 hours.

With the addition of the proposed 30 Van Ness project in the Existing + Project configuration, the number of locations where the wind hazard criterion is predicted to be exceeded is anticipated to remain the same as in the Existing configuration (Locations 2, 3, 5, 6, 9, 10, 13, 21, 22, 41, 63, 97, 102, 109. 110, 114 and 158 -160 in **Figure 2b and Table 2**) for a total of 322 hours. Due to the addition of on-site wind control measures such as a sculptural feature, overhead canopies, vertical wind screens and landscaping, some existing onsite and nearby windy areas are expected to improve (Locations 12, 20 and 24 in **Figure 2b**) whereas some additional off-site locations are predicted to exceed the hazard criterion (Locations 22, 41 and 97 in Figure 2b). Overall, the number of locations with hazard wind conditions remains the same as Existing but the total number of hours with hazard wind conditions reduces from 508 to 322. Since the off-site landscaping modeled in the wind tunnel test is the same for both Existing and Existing + Project configurations, the overall effects of landscaping off-site are similar for both tests. The addition of proposed on-site landscaping (along with the combination of other wind control measures) is expected to improve the wind hazard conditions compared to the Existing scenario.

3.3 Wind Conditions – Bike Lanes (Locations 164 through 181)

Average wind speeds in the Existing configuration at all bike lane locations are 7.7mph (**Table 3**). With the addition of the proposed 30 Van Ness project, the average wind speeds at all bike lane locations are predicted to be 8.0 mph (**Table 3**).

4 ADDITIONAL COMMENTS

It is our understanding that a taller version of the podium (150 feet) is also being considered by the project sponsor. Based on previous wind tunnel tests of various podium height options for the 30 Van Ness project, it is our opinion that a taller version of the podium (at 150 feet) could achieve wind comfort and hazard results that are comparable to the shorter version (at 120 feet) presented herein. However, wind tunnel tests will be required to develop the specific wind control strategies for the taller version of the podium and quantify the results.

5 APPLICABILITY

The wind conditions presented in this report pertain to the proposed 30 Van Ness project as detailed in the architectural design drawing listed in **Appendix A**. Should there be any design changes that deviate from the drawing, the wind condition predictions presented may change. Therefore, if changes in the design are made, it is recommended that RWDI be contacted and requested to review their potential effects on wind conditions.

TABLES

Table 1: Wind Comfort Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
1	15	28	e	17	35	2	e
2	21	47	e	22	49	1	e
3	22	47	e	23	50	1	e
4	17	35	e	17	38	0	e
5	19	42	e	18	37	-1	e
6	18	35	e	16	29	-2	e
7	12	16	e	13	18	1	e
8	14	22	e	15	26	1	e
9	25	50	e	25	49	0	e
10	23	51	e	23	51	0	e
11	15	28	e	15	25	0	e
12	22	49	e	13	19	-9	e
13	22	51	e	19	45	-3	e
14	12	18	e	11	10	-1	
15	16	29	e	16	30	0	e
16	12	15	e	11	10	-1	
17	7	1		8	1	1	
18	7	0		8	3	1	
19	15	28	e	14	22	-1	e
20	20	46	e	17	35	-3	e
21	26	60	e	20	46	-6	e
22	13	17	e	19	41	6	e
23	11	10		12	16	1	e
24	22	50	e	14	22	-8	e
25	8	2		14	22	6	e
26	8	2		11	10	3	
27	9	3		16	28	7	e
28	14	24	e	18	36	4	e
29	13	16	e	17	34	4	e
30	14	18	e	16	31	2	e
31	10	8		18	37	8	e
32	14	22	e	14	23	0	e
33	10	8		18	38	8	e
34	17	35	e	19	42	2	e
35	11	10		14	20	3	e
36	20	47	e	20	47	0	e
37	13	16	e	13	17	0	e
38	13	17	e	13	19	0	e
39	10	7		10	6	0	
40	16	29	e	16	30	0	e
41	17	33	e	18	37	1	e
42	14	22	e	15	26	1	e
43	14	19	e	14	22	0	e
44	8	1		8	1	0	
45	7	1		7	1	0	
46	9	3		8	2	-1	
47	11	10		11	10	0	

Table 1: Wind Comfort Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
48	13	18	e	13	17	0	e
49	12	13	e	13	14	1	e
50	7	0		8	1	1	
51	13	18	e	12	15	-1	e
52	10	6		10	5	0	
53	8	1		8	1	0	
54	14	19	e	14	19	0	e
55	13	20	e	13	20	0	e
56	14	22	e	14	22	0	e
57	14	19	e	13	17	-1	e
58	14	23	e	14	22	0	e
59	7	1		7	1	0	
60	-	-	-	-	-	-	-
61	-	-	-	-	-	-	-
62	-	-	-	-	-	-	-
63	22	49	e	21	48	-1	e
64	14	23	e	14	23	0	e
65	16	28	e	15	27	-1	e
66	12	15	e	12	14	0	e
67	13	20	e	13	19	0	e
68	10	5		10	4	0	
69	15	29	e	15	28	0	e
70	17	32	e	17	31	0	e
71	6	0		6	0	0	
72	14	22	e	14	22	0	e
73	16	28	e	15	27	-1	e
74	16	31	e	16	30	0	e
75	15	24	e	15	24	0	e
76	15	26	e	15	25	0	e
77	16	30	e	16	29	0	e
78	14	22	e	14	21	0	e
79	17	36	e	16	32	-1	e
80	12	13	e	12	13	0	e
81	13	19	e	13	18	0	e
82	16	30	e	15	28	-1	e
83	15	25	e	14	24	-1	e
84	10	7		11	10	1	
85	13	20	e	14	22	1	e
86	11	10		12	13	1	e
87	12	15	e	11	10	-1	
88	12	14	e	12	13	0	e
89	11	10		11	10	0	
90	12	15	e	11	10	-1	
91	12	13	e	11	10	-1	
92	9	5		10	5	1	
93	14	21	e	14	22	0	e
94	11	10		14	21	3	e

Table 1: Wind Comfort Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
95	13	20	e	13	21	0	e
96	10	8		12	13	2	e
97	14	24	e	20	42	6	e
98	14	24	e	16	28	2	e
99	10	8		11	10	1	
100	9	3		13	16	4	e
101	15	26	e	16	30	1	e
102	21	48	e	22	48	1	e
103	17	34	e	17	32	0	e
104	16	32	e	19	37	3	e
105	11	10		11	10	0	
106	13	17	e	12	15	-1	e
107	15	24	e	14	21	-1	e
108	16	31	e	16	29	0	e
109	25	57	e	25	58	0	e
110	21	48	e	21	49	0	e
111	13	19	e	12	15	-1	e
112	13	18	e	15	26	2	e
113	11	10		13	21	2	e
114	19	39	e	19	41	0	e
115	14	23	e	15	27	1	e
116	13	19	e	13	18	0	e
117	11	10		11	10	0	
118	14	23	e	14	21	0	e
119	14	24	e	14	22	0	e
120	17	38	e	17	35	0	e
121	15	26	e	14	23	-1	e
122	13	19	e	12	15	-1	e
123	11	10		10	7	-1	
124	15	24	e	14	23	-1	e
125	14	21	e	13	19	-1	e
126	11	10		11	10	0	
127	11	10		11	10	0	
128	12	12	e	11	10	-1	
129	13	18	e	13	18	0	e
130	7	0		6	0	-1	
131	12	15	e	12	15	0	e
132	10	6		10	5	0	
133	16	30	e	16	29	0	e
134	15	27	e	15	25	0	e
135	12	13	e	12	12	0	e
136	8	1		8	1	0	
137	6	0		6	0	0	
138	11	10		11	10	0	
139	13	18	e	13	17	0	e
140	11	10		11	10	0	
141	12	14	e	12	12	0	e

Table 1: Wind Comfort Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Exceeds	Wind Speed Exceeded 10% of Time (mph)	% of Time Wind Speed Exceeds 11 mph (%)	Speed Change Relative to Existing (mph)	Exceeds
142	10	7		11	10	1	
143	11	10		11	10	0	
144	9	2		9	2	0	
145	8	1		8	1	0	
146	11	10		10	7	-1	
147	13	15	e	12	13	-1	e
148	12	13	e	11	10	-1	
149	10	5		9	4	-1	
150	13	20	e	13	19	0	e
151	15	24	e	15	24	0	e
152	10	7		10	6	0	
153	14	23	e	14	23	0	e
154	13	19	e	13	19	0	e
155	12	14	e	12	15	0	e
156	12	14	e	13	19	1	e
157	15	27	e	15	27	0	e
158	17	32	e	17	33	0	e
159	17	31	e	17	32	0	e
160	17	34	e	17	34	0	e
161	14	21	e	13	21	-1	e
162	11	10		11	10	0	
163	13	16	e	13	15	0	e

SUMMARY	Average (mph)	Average (%)	Total	Average (mph)	Average (%)	Speed Change (mph)	Total
	13.4	**20.2**	**112 ---- 160**	**13.7**	**20.9**	**0.30**	**116 ---- 160**

Table 2: Wind Hazard Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
1	28	0		31	0	0	
2	38	3	e	39	5	2	e
3	38	12	e	40	22	10	e
4	31	0		31	0	0	
5	42	20	e	40	9	-11	e
6	41	11	e	38	3	-8	e
7	22	0		23	0	0	
8	25	0		30	0	0	
9	43	60	e	42	40	-20	e
10	44	29	e	42	19	-10	e
11	29	0		28	0	0	
12	40	13	e	26	0	-13	
13	42	20	e	38	3	-17	e
14	22	0		21	0	0	
15	29	0		29	0	0	
16	23	0		20	0	0	
17	14	0		15	0	0	
18	13	0		17	0	0	
19	29	0		26	0	0	
20	38	3	e	33	0	-3	
21	52	144	e	38	2	-142	e
22	28	0		42	18	18	e
23	23	0		26	0	0	
24	47	47	e	30	0	-47	
25	17	0		29	0	0	
26	17	0		24	0	0	
27	18	0		35	0	0	
28	30	0		35	0	0	
29	28	0		34	0	0	
30	31	0		29	0	0	
31	21	0		30	0	0	
32	26	0		29	0	0	
33	19	0		35	0	0	
34	31	0		35	0	0	
35	22	0		24	0	0	
36	35	0		35	0	0	
37	31	0		30	0	0	
38	25	0		23	0	0	
39	19	0		18	0	0	
40	29	0		30	0	0	
41	35	0		38	3	3	e
42	25	0		26	0	0	
43	29	0		32	0	0	
44	14	0		15	0	0	
45	15	0		15	0	0	
46	18	0		17	0	0	
47	22	0		22	0	0	

Table 2: Wind Hazard Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
48	28	0		27	0	0	
49	28	0		29	0	0	
50	13	0		15	0	0	
51	23	0		22	0	0	
52	19	0		18	0	0	
53	15	0		15	0	0	
54	28	0		27	0	0	
55	25	0		24	0	0	
56	29	0		29	0	0	
57	29	0		28	0	0	
58	27	0		26	0	0	
59	15	0		15	0	0	
60	-	-	-	-	-	-	-
61	-	-	-	-	-	-	-
62	-	-	-	-	-	-	-
63	42	20	e	42	19	-1	e
64	27	0		26	0	0	
65	26	0		26	0	0	
66	23	0		22	0	0	
67	26	0		25	0	0	
68	20	0		20	0	0	
69	30	0		29	0	0	
70	35	0		34	0	0	
71	12	0		12	0	0	
72	30	0		29	0	0	
73	29	0		29	0	0	
74	29	0		28	0	0	
75	31	0		29	0	0	
76	28	0		27	0	0	
77	29	0		28	0	0	
78	26	0		25	0	0	
79	29	0		29	0	0	
80	26	0		25	0	0	
81	25	0		24	0	0	
82	28	0		27	0	0	
83	28	0		30	0	0	
84	24	0		26	0	0	
85	25	0		26	0	0	
86	22	0		22	0	0	
87	20	0		20	0	0	
88	22	0		21	0	0	
89	21	0		21	0	0	
90	22	0		19	0	0	
91	21	0		18	0	0	
92	19	0		18	0	0	
93	27	0		26	0	0	
94	22	0		28	0	0	

Table 2: Wind Hazard Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
95	24	0		25	0	0	
96	22	0		27	0	0	
97	28	0		42	20	20	e
98	26	0		32	0	0	
99	22	0		21	0	0	
100	17	0		27	0	0	
101	29	0		27	0	0	
102	37	1	e	41	17	16	e
103	30	0		29	0	0	
104	31	0		34	0	0	
105	23	0		24	0	0	
106	23	0		21	0	0	
107	25	0		24	0	0	
108	31	0		31	0	0	
109	48	80	e	51	102	22	e
110	43	22	e	43	25	3	e
111	24	0		23	0	0	
112	25	0		29	0	0	
113	18	0		24	0	0	
114	37	4	e	39	5	1	e
115	25	0		27	0	0	
116	23	0		23	0	0	
117	20	0		21	0	0	
118	26	0		27	0	0	
119	26	0		25	0	0	
120	31	0		30	0	0	
121	27	0		26	0	0	
122	23	0		21	0	0	
123	22	0		22	0	0	
124	26	0		25	0	0	
125	27	0		26	0	0	
126	21	0		20	0	0	
127	21	0		21	0	0	
128	22	0		21	0	0	
129	22	0		22	0	0	
130	12	0		12	0	0	
131	22	0		22	0	0	
132	18	0		18	0	0	
133	33	0		32	0	0	
134	29	0		28	0	0	
135	24	0		23	0	0	
136	15	0		14	0	0	
137	11	0		11	0	0	
138	21	0		21	0	0	
139	24	0		25	0	0	
140	21	0		21	0	0	
141	24	0		23	0	0	

Table 2: Wind Hazard Conditions

Location	Existing			Existing + Project			
	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Exceeds	Wind Speed Exceeded 1hr/year (mph)	Hours per Year Wind Speed Exceeds Hazard Criteria	Hours Change Relative to Existing	Exceeds
142	19	0		20	0	0	
143	25	0		23	0	0	
144	17	0		17	0	0	
145	13	0		13	0	0	
146	19	0		18	0	0	
147	22	0		21	0	0	
148	21	0		20	0	0	
149	19	0		18	0	0	
150	25	0		24	0	0	
151	32	0		31	0	0	
152	19	0		19	0	0	
153	28	0		28	0	0	
154	24	0		24	0	0	
155	22	0		22	0	0	
156	26	0		28	0	0	
157	31	0		31	0	0	
158	41	14	e	40	7	-7	e
159	36	1	e	36	1	-1	e
160	39	4	e	37	2	-2	e
161	25	0		25	0	0	
162	23	0		23	0	0	
163	30	0		29	0	0	

SUMMARY	Average (mph)	Total Hours	Total	Average (mph)	Total Hours	Hours Change	Total
	26	**508**	**19 ---- 160**	**26**	**322**	**-186**	**19 ---- 160**

Table 3: Bike Lane Wind Conditions - Informational

Location	Mean Wind Speed (mph)	
	Existing	Existing + Project
164	5	5
165	9	4
166	6	6
167	7	7
168	5	6
169	6	7
170	9	10
171	7	10
172	7	9
173	12	13
174	8	9
175	10	11
176	6	7
177	11	10
178	6	6
179	12	12
180	6	7
181	7	7

SUMMARY	Average (mph)	Average (mph)
	7.7	**8.0**

FIGURES

APPENDIX A

APPENDIX A:
DRAWING LIST FOR MODEL CONSTRUCTION

The drawings and information listed below were received from Lendlease and were used to construct the scale model of the proposed 30 Van Ness project. Should there be any design changes that deviate from this list of drawings, the results may change. Therefore, if changes in the design are made, it is recommended that RWDI be contacted and requested to review their potential effects on wind conditions.

File Name	File Type	Date Received (dd/mm/yyyy)
2018.10.10 30VN wind RWDI	SketchUp	10/11/2018

APPENDIX B

APPENDIX B:

SAN FRANCISCO PLANNING CODE SECTION 148

REDUCTION OF GROUND-LEVEL WIND CURRENTS IN C-3 DISTRICTS

a) Requirement and Exception. In C-3 Districts, buildings and additions to existing buildings shall be shaped, or other wind-baffling measures shall be adopted, so that the developments will not cause ground-level wind currents to exceed, more than 10 percent of the time year round, between 7:00 a.m. and 6:00 p.m., the comfort level of 11 m.p.h. equivalent wind speed in areas of substantial pedestrian use and seven m.p.h. equivalent wind speed in public seating areas.

When preexisting ambient wind speeds exceed the comfort level, or when a proposed building or addition may cause ambient wind speeds to exceed the comfort level, the building shall be designed to reduce the ambient wind speeds to meet the requirements. An exception may be granted, in accordance with the provisions of Section 309, allowing the building or addition to add to the amount of time that the comfort level is exceed by the least practical amount if (1) it can be shown that a building or addition cannot be shaped and other wind-baffling measures cannot be adopted to meet the foregoing requirements without creating an unattractive and ungainly building form and without unduly restricting the development potential of the building site in question, and (2) it is concluded that, because of the limited amount by which the comfort level is exceeded, the limited location in which the comfort level is exceeded, or the limited time during which the comfort level is exceeded, the addition is insubstantial.

No exception shall be granted and no building or addition shall be permitted that causes equivalent wind speeds to reach or exceed the hazard level of 26 miles per hour for a single hour of the year.

b) Definition. The term "equivalent wind speed" shall mean an hourly mean wind speed adjusted to incorporate the effects of gustiness or turbulence on pedestrians.

c) Guidelines. Procedures and Methodologies for implementing this section shall be specified by the Office of Environmental Review of the Department of City Planning. (added by Ord. 414-85, App. 9/17/85)

APPENDIX G-5
30 VAN NESS AVENUE DESIGN CHANGE WIND MEMORANDUM

600 Southgate Drive
Guelph ON Canada
N1G 4P6

Tel: +1.519.823.1311
Fax: +1.519.823.1316

MEMORANDUM

DATE:	2019-06-26	**RWDI Reference No:** 1701249
TO:	Alana Callagy	**EMAIL:** Alana.Callagy@sfgov.org
	Elizabeth White	**EMAIL:** Elizabeth.White@sfgov.org
FROM:	Nishat Nourin	**EMAIL:** Nishat.Nourin@rwdi.com
	Hanqing Wu	**EMAIL:** Hanqing.Wu@rwdi.com
	Frank Kriksic	**EMAIL:** Frank.Kriksic@rwdi.com
RE:	**30 Van Ness – Pedestrian Level Wind Study – Comments on Design Change**	

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by Lendlease (the project sponsor) to assess the pedestrian level wind conditions for the proposed project at 30 Van Ness Avenue in San Francisco, California. RWDI finalized the wind report for the project on March 12, 2019, with a design version that complies with San Francisco Planning Code Section 148. [1]

On April 5, 2019, RWDI was informed of a design change to reduce shadow impacts on Civic Center Plaza. This design change involves shifting the proposed tower 6 feet to the south and minor revisions to the tower rooftop. Image 1a shows the west elevation of the proposed development that was analyzed in the ~~draft~~ report on March 12, 2019. Image 1b shows the updated elevation with the proposed tower shift to the south, minor revisions to the roof and the proposed wind control measures (10 feet deep solid canopy along Fell Street, 10 feet deep porous canopy along Market Street and Van Ness Avenue, an elevated porous vertical screen at the corner of Market Street and Van Ness Avenue, and a sculptural feature at grade level at the corner of Market Street and Van Ness Avenue, as shown in Image 1B).

The proposed changes (i.e. shifting the tower 6 feet south and minor revisions to the tower roof) are considered minor with respect to impact on wind conditions at grade level. Based on our previous wind tunnel tests of various larger massing and architectural changes on this project, it is our opinion that these design changes are not expected to alter the pedestrian level wind comfort and hazard conditions predicted in the report sent on March 12, 2019.

[1] 30 Van Ness, San Francisco, CA – Pedestrian Wind Study, RWDI 1701249, March 12, 2019

Alana Callagy
San Francisco Planning Department
RWDI#1701249
JUNE 26, 2019

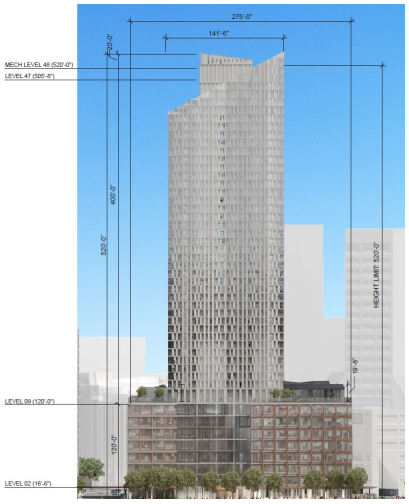


Image 1a: West elevation of the design option tested in the wind tunnel and reported on March 12, 2019

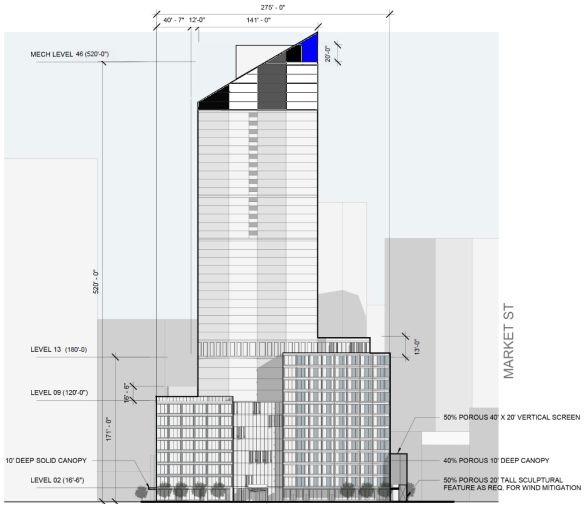


Image 1b: West elevation of the design option documented in this memorandum

The Cumulative analysis was run as part of the Hub Plan wind study by RWDI. The Cumulative scenario analyzes the proposed project in combination with reasonably foreseeable development. The results of the Cumulative scenario wind conditions are contained in the "*Market/ Octavia Hub Plan – San Francisco, CA – Pedestrian Wind Study, RWDI Project 1603628*" issued on January 18, 2019. The proposed 6-foot tower shift and minor revisions to the tower roof are not expected to alter the wind comfort and hazard conditions predicted for the Cumulative scenario.

Should you have any questions or require additional information, please do not hesitate to contact us.

Yours truly,

Rowan Williams Davies & Irwin Inc. (RWDI)

APPENDIX G-6
98 FRANKLIN STREET WIND STUDY

98 Franklin Street
San Francisco, CA

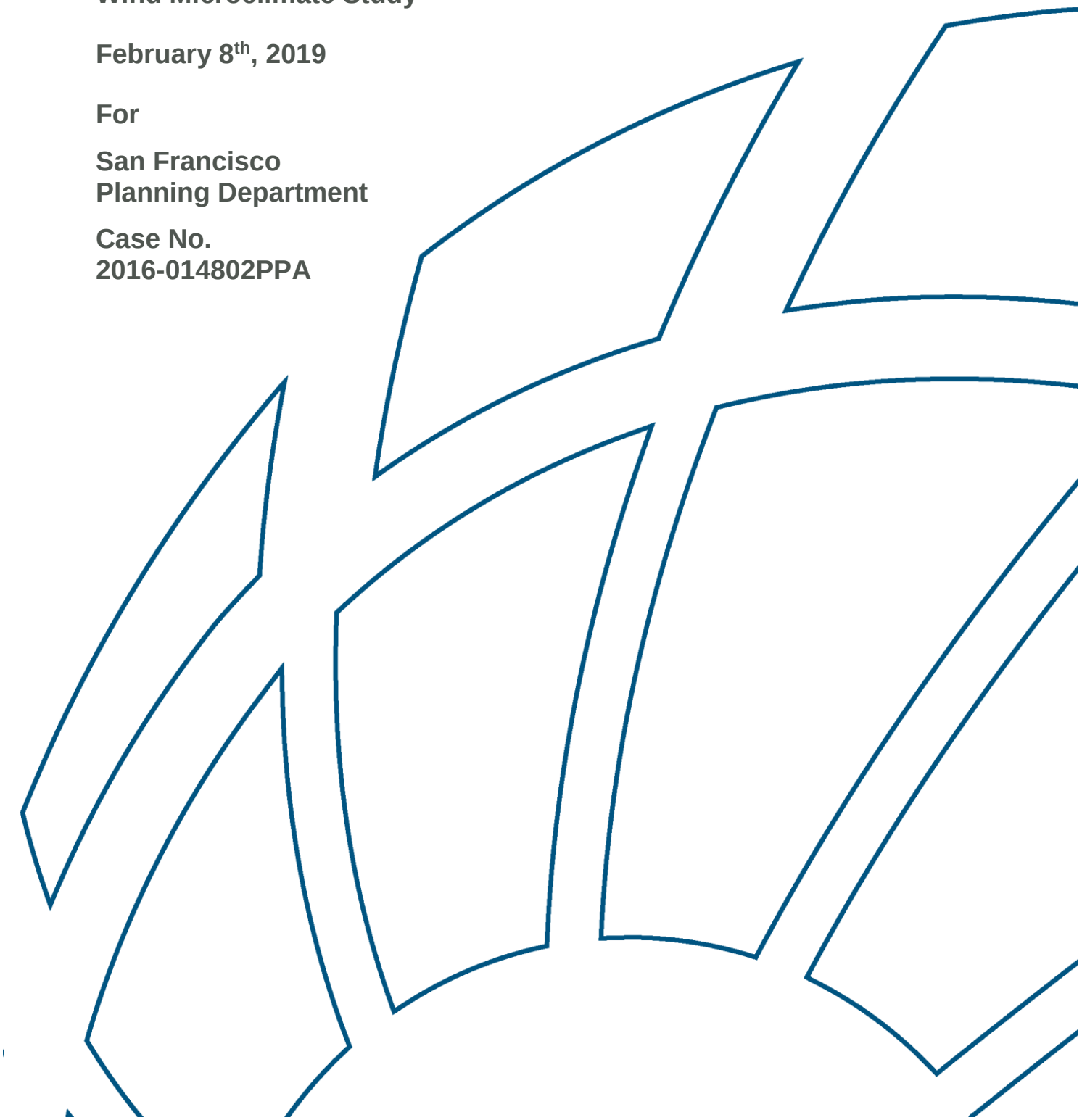
Wind Microclimate Study

February 8th, 2019

For

San Francisco
Planning Department

Case No.
2016-014802PPA



Report Title	**98 Franklin Street San Francisco, CA Wind Microclimate Study**	
For	**San Francisco Planning Department**	
Document No:	**432357rep1v5**	**Release: 5**
Report Date:	**February 8th, 2019**	

	Name	Signature	Date
Author	**Ms T. Syafizan**		**February 8th, 2019**
Approver	**Dr D. Hankin**		**February 8th, 2019**
Authorizer	**Dr R. Stanfield**		**February 8th, 2019**

Issue	Date	Description
1	**July 24th, 2018**	**First Issue**
2	**July 27th, 2018**	**Second Issue**
3	**August 6th, 2018**	**Third Issue**
4	**January 8th, 2019**	**Fourth Issue**
5	**February 8th, 2019**	**Fifth Issue**

98 Franklin Street
San Francisco, CA
Wind Microclimate Study

EXECUTIVE SUMMARY

Background

BMT has conducted a pedestrian-level wind study for the proposed 98 Franklin Street (hereafter "Proposed Project") located at the junction of Oak Street and Franklin Street and is in zoning district C-3-G, San Francisco, California. The purpose of the wind study is to assess the probability of the Proposed Project to cause local wind speeds to exceed "comfort" and "hazard" criteria at publicly accessible points in the project vicinity, in accordance with Section 148 of the San Francisco Planning Code.

Test Criteria

The following significance criteria are from Appendix B of the San Francisco Planning Environmental Review Guidelines and are used to determine the level of impacts related to wind. The Proposed Project would result in a significant impact if it would alter wind in a manner that substantially affects public areas.

Planning Code Section 148 establishes two wind comfort criteria that require, upon introduction of the Proposed Project, that equivalent wind speeds do not exceed 11 mile-per-hour (mph) more than 10% of the time between 7:00am and 6:00pm throughout the year, in areas of substantial pedestrian use, and seven mph in public seating areas.

Section 148 also establishes a wind hazard criterion that requires, upon introduction of new buildings or additions to existing buildings, that ground-level equivalent wind speeds do not exceed 26 mph for more than a single hour during the year.

Test Scenarios

The evaluation of wind comfort and hazards was carried out by testing a 1:300 scale model of the Proposed Project in a boundary layer wind tunnel in accordance with standard City of San Francisco test protocols. A total of 85 City-approved publicly-accessible ground-level locations ("test points") have been selected on project-area sidewalks and sidewalks corners within a 1,500-foot radius of the project vicinity in order to measure and then compare wind conditions for the following test scenarios:

- **Existing Scenario**: the existing condition, including buildings currently under construction, which serves as the baseline wind conditions in the study area
- **Existing Plus Project Scenario**: adding the proposed project to the existing conditions
- **Existing Plus Project with Mitigation Scenario**: adding wind mitigation measures to the project

It is understood that the cumulative scenario has been assessed as part of the wider Hub Plan wind study conducted by RWDI ("Market/Octavia Hub Plan", RWDI Report #1603628, dated April 20th, 2018).

Summary Results

The boundary layer wind tunnel study has assessed the wind microclimate in the 98 Franklin Street study area. On the basis of the wind tunnel modelling, the following conclusions have been drawn:

- Within the Existing Scenario, wind conditions exceed the comfort criterion at 64 out of 85 test points, with a combined average hourly wind speed of 14.2 mph. Under the Existing Scenario, wind conditions exceed the hazard criterion at 17 out of 85 test points, which collectively exceed the hazard criterion for a duration of 457 hours annually.

- Within the Existing Plus Project Scenario, wind conditions would exceed the comfort criterion at 71 out of 85 test points, which would represent a net increment of 7 test points compared to Existing Scenario. The average wind speed over all the test points would be increased from 14.2 mph in the Existing Scenario to 15.1 mph in the Existing Plus Project Scenario. The number of test points in which wind conditions exceed the hazard criterion would be increased from 17 in the Existing Scenario to 21 in the Existing Plus Project Scenario. Additionally, the total duration of hazardous wind conditions would be increased from 457 hours to 522 hours, representing a net increment of 65 hours of hazardous wind conditions compared to the Existing Scenario.

- Wind mitigation measures have been developed, which comprise of evergreen trees along Oak Street and Franklin Street and a canopy along Franklin Street. Further details of the mitigation measures are provided in **Figure D.5**.

- Within the Existing Plus Project with Mitigation Scenario, wind conditions would exceed the comfort criterion at 69 out of 85 test points, which would represent a net decrement of 2 test points compared to the Existing Plus Project Scenario. The number of test points in which wind conditions exceed the hazard criterion would be decreased from 17 in the Existing Scenario to 14 in the Existing Plus Project with Mitigation Scenario. The total duration of hazardous wind conditions would be decreased from 457 hours to 427 hours, representing a net decrement of 30 hours of hazardous wind conditions compared to the Existing Scenario.

98 Franklin Street
San Francisco, CA
Wind Microclimate Study

1. Introduction

BMT has worked with the Related to conduct a pedestrian wind microclimate study for the proposed 98 Franklin Street (hereafter "Proposed Project") in San Francisco, California.

The purpose of the wind study is to assess the probability of whether the project would result in local wind speeds that would exceed "comfort" and "hazard" thresholds specified in San Francisco Planning Code Section 148 at publicly accessible points in the project vicinity in order to determine whether wind effects are suitable for the pedestrian environment.

1.1. Study Area

1.1.1. Project Site

The 23,753-square-foot project site is located on the block bounded by Market Street to the south, Franklin Street to the west, Oak Street to the north, and Van Ness Avenue to the east in the Civic/Downtown neighborhood, and within the C-3-G District and Van Ness and Market Downtown Residential Special Use District.

The site location is presented within the context of the wider surrounding area in **Figure 1.1**.

1.1.2. Project Description

The proposed project would remove the existing parking lot and construct a 380-foot-tall, mixed use building approximately 469,100 square feet in size.

1.2. Test Scenarios

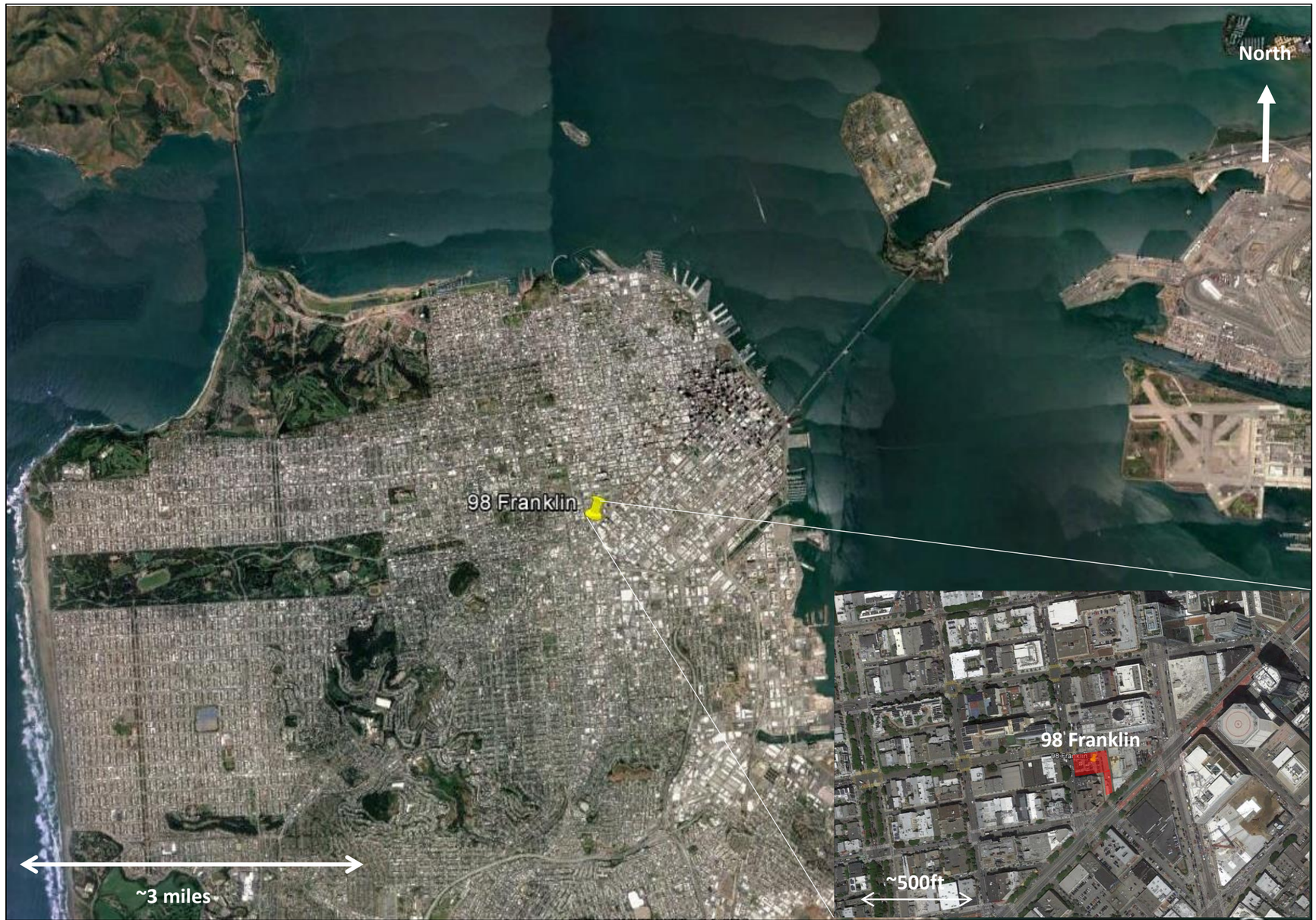
The study considers the following scenarios:

- **Existing Scenario:** the existing condition, including buildings currently under construction which serves as the baseline wind conditions in the study area
- **Existing Plus Project Scenario:** adding the Proposed Project to the existing conditions
- **Existing Plus Project with Mitigation Scenario:** adding wind mitigation measures to the project

The Existing Scenario is tested in order to characterize the wind environment on the project site and in the study area as it exists today without the Proposed Project. The Existing Plus Project Scenario entails testing a 1:300 scale model of the Proposed Project within the existing setting, in order to investigate changes to ground-level winds that the Proposed Project could affect. The Existing Plus Project with Mitigation Scenario added evergreen Project trees along Franklin Street and along Oak Street, including on the north-west corner of the Oak/Franklin intersection, replaced four trees at the north side along Oak Street with evergreen trees, removed four existing trees along Franklin Street, and implemented a ~11ft (width) x ~126ft (length) x ~68ft (height) canopy (option 6B) along the western façade of the proposed Project (along Franklin Street) to examine the changes to ground-level wind speeds could have. The Project trees are shown in **Figure 1.2**.

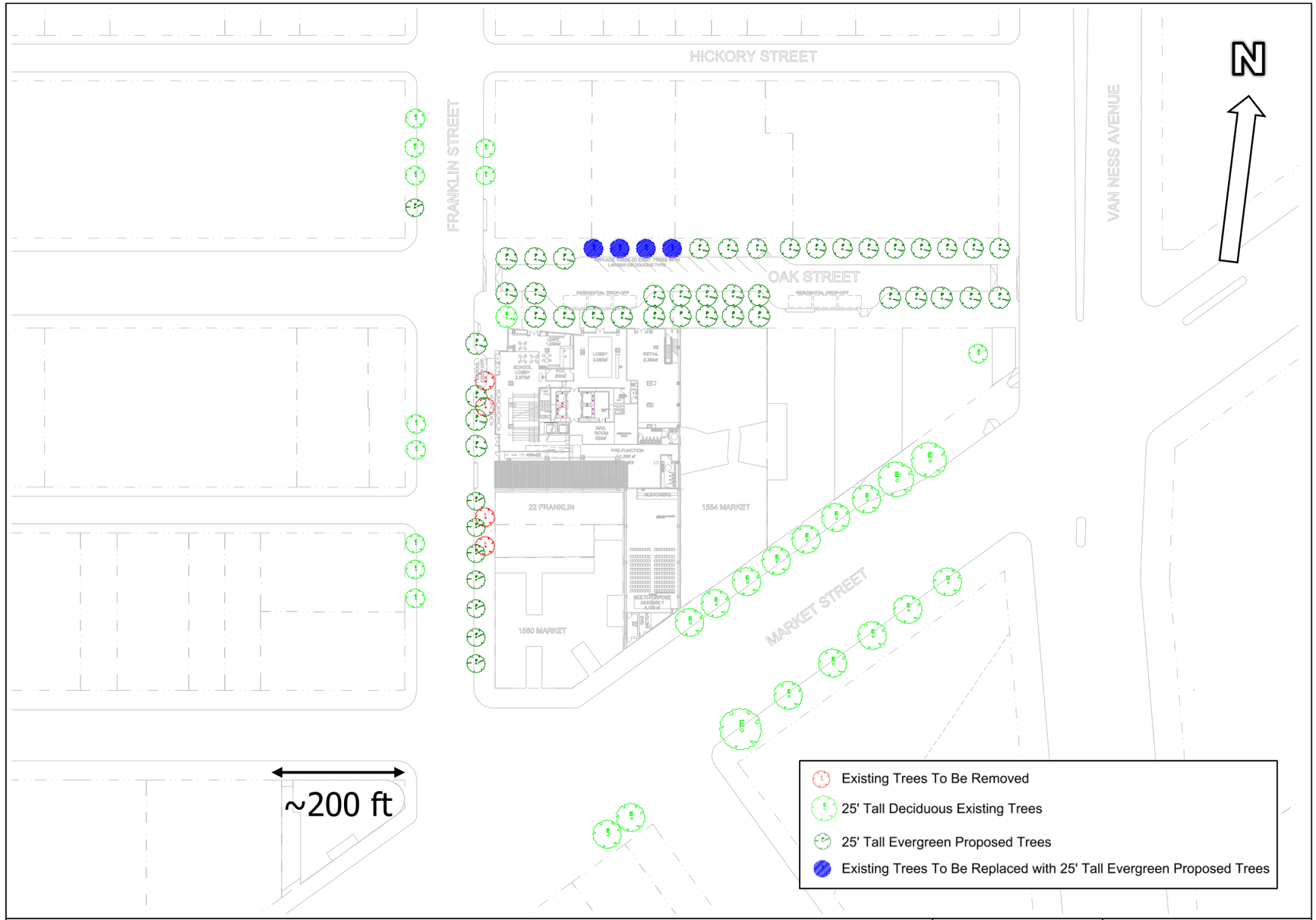
Figures 1.3 and **1.4** show the Existing Scenario, Existing Plus Project Scenario, respectively. Additionally, Appendix C contains photographs of the wind tunnel models of each scenario.

Figure 1.1: Site Location



432357 – 98 Franklin Aerial View of Development	BMT	Drawing No: 432357/FIG -1.1	By: T. Syafizan Date: July 16th, 2018

Figure 1.2: The Tree Plan

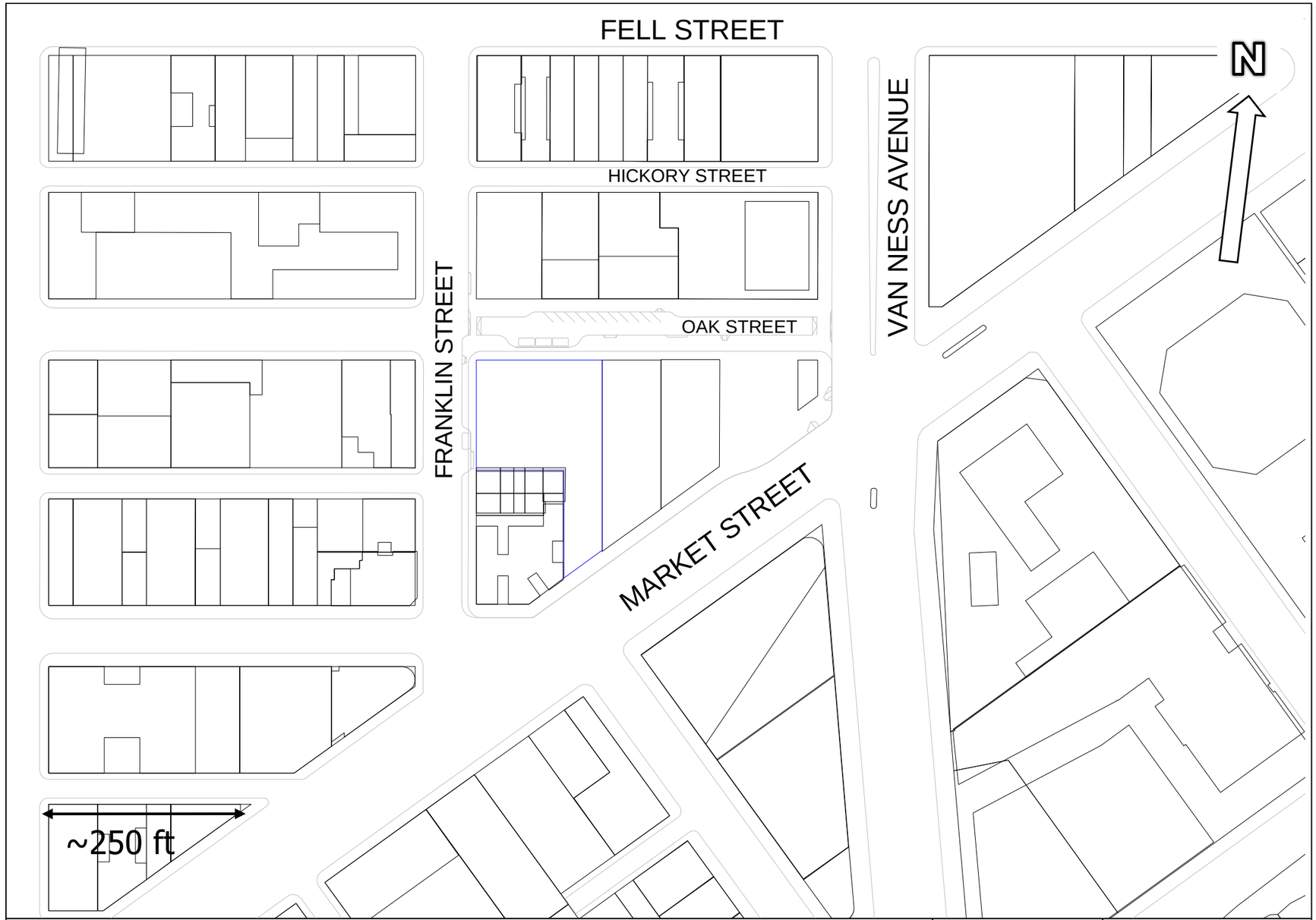


432357 – 98 Franklin Trees Plan	BMT	Drawing No: 432357/FIG -1.2	By: T. Syafizan Date: July 31st, 2018

Figure 1.3: Existing Scenario

432357 – 98 Franklin Existing Scenario	BMT	Drawing No: 432357/FIG -1.3	By: T. Syafizan Date: July 31st, 2018

Figure 1.4: Existing Plus Project Scenario



432357 – 98 Franklin Existing Plus Project Scenario	BMT	Drawing No: 432357/FIG -1.4	By: T. Syafizan Date: July 31st, 2018

2. The Assessment of Wind Microclimate

A microclimate can be defined as the distinctive climate of a small-scale area. The weather variables in a microclimate, such as wind, may be different to the conditions prevailing over the area as a whole.

Wind microclimate assessments consider the wind conditions that would result upon the introduction of a new development into an established setting. Wind speed data generated by tunnel testing assists decision-makers to determine whether a project's wind conditions would be suitable or unsuitable, and whether or not design adjustments or wind reduction measures would be required to address potentially hazardous wind effects or any pedestrian comfort issues. It is for these purposes, that wind microclimate assessments are undertaken.

2.1. Buildings, the Built Environment and Wind Speed

The direction and speed of wind currents can be altered by natural features of the land or by buildings and structures. A number of basic features can influence the wind flows around buildings. These include the general building envelope, the cross-sectional shape, the building orientation (particularly in relation to the prevailing wind direction), the overall height and proximity to other buildings and the general exposure of the site. Groups of buildings clustered together tend to act as obstacles that reduce wind speeds; the heights, massing, and orientations or profiles of the buildings are some of the factors that can affect wind speeds. When a building is much taller than those around it, rather than a similar height, it can intercept and redirect winds downward that might otherwise flow overhead. The winds can be directed down the vertical face of the building to ground level, and these redirected winds can be relatively strong and relatively turbulent. The massing of a building can affect wind speeds. In general, slab-shaped buildings have the greatest potential to accelerate ground-level winds, while buildings that have unusual shapes or are more geometrically complex tend to deflect the wind away from reaching to the pedestrian level.

The building height relative to the adjacent buildings is particularly important since higher level winds can be deflected by the building towards ground level. In general terms, for a given cross-sectional shape the higher the building, the windier it would be at ground level. Because of this downward deflection of high-level winds, significant localized acceleration can occur around the base of a building, particularly near the corners of the building. This is demonstrated by the common experience of windy conditions near tall buildings even on a relatively calm day.

The corner geometry in particular is important because sharp edged corners cause separated flows with strong wind speed gradients (rapid changes over a short distance). Softer, or more rounded corners improve this, although some acceleration still occurs.

The proximity of adjacent buildings is an important consideration with regard to wind shielding and funneling (channeling). The potential for local wind accelerations and decelerations due to interaction with local structures must be taken into account when assessing the local wind environment. Therefore, the adjacent relevant existing buildings have been incorporated into the wind model with more detail in regards to existing shape, massing, and architectural features.

3. The San Francisco Wind Climate

Between 1945 and 1950, data describing the speed, direction and frequency of occurrence of winds within the San Francisco area were recorded at the old San Francisco Federal Building at 50 United Nations Plaza.

Analysis of the wind data shows that average wind speeds in San Francisco are greater during summer and lower during winter. Strongest winds, however, tend to prevail during winter. Of the 16 primary wind directions, 4 have the greatest frequency of occurrence and these comprise the strongest and most commonly occurring winds. These are winds blowing from northwest, west-northwest, west, and west-southwest. However, boundary layer wind tunnel testing was conducted for all wind directions in increments of 22.5° for a total of 16 wind directions.

Ground roughness is an important factor in the development of the wind velocity close to the ground, as a rougher surface will slow the wind close to the ground. The topographic roughness varies throughout the City and surrounding region, with the smoothest in the region being the Pacific Ocean and the attached inland bays. Although the smoothness of the water varies with wave height, it can generally be assumed that the velocity of wind coming off the ocean is relatively high even at low elevations.

For the wind blowing from a quadrant centered on the west, the study area sits on the downwind edge of the San Francisco peninsula. While this is true, the upwind terrain, topography and building morphology do relatively little to impede strong prevailing winds originating from the Pacific. The buildings west of Franklin Street are typically relatively short – less than 80 feet tall – and therefore do little to intercept the most common winds from the northwest, west-northwest, west, and west-southwest. Thus, strong winds blow across the peninsula and reach the study area, which, in its immediate vicinity, is exposed to the west.

4. Assessment Criteria

4.1. Pedestrian Comfort and Hazard Wind Speeds

At each area investigated, the suitability of ground level wind conditions in terms of "comfort" and the presence of "hazards" was assessed based upon local hourly-mean wind speed as defined by the San Francisco Planning Code Section 148.

4.2. San Francisco Planning Environmental Review Guidelines and Criteria

Planning Code Section 148 establishes wind comfort and wind hazard criteria for certain zoning districts: The Downtown (C-3-G) Districts which includes the project site, the Downtown Residential (DTR) Districts, the Folsom and Main Residential/Commercial Special Use District, the Van Ness Special Use District, and certain zoning districts in the South of Market neighborhood. The Proposed Project is in the C-G-3 District so Section 148 of the Planning Code governs this development.

Planning Code Section 148 establishes equivalent wind speeds of 7 miles per hour (mph) as the comfort criterion for seating areas and 11 mph as the comfort criterion for areas of substantial pedestrian use. New buildings and additions to existing buildings may not cause ground-level winds to exceed 11 mph more than 10 percent of the time year-round between 7:00 AM and 6:00 PM.

If existing wind speeds exceed the comfort criteria, or when a project would result in new exceedances of the comfort criteria, the Planning Commission may grant an exception pursuant to Planning Code Section 309 provided that the building or addition cannot be designed to meet the comfort criteria without creating an unattractive and ungainly building form and without unduly restricting the development potential of the site. In granting an exception pursuant to Section 309, the Planning Commission must determine that the exceedances of the comfort criteria would be insubstantial because of the limited amount by which the comfort criteria are exceeded, the limited location in which the comfort criteria are exceeded, or the limited time during which the comfort criteria are exceeded.

Section 148 also establishes a wind hazard criterion of an equivalent wind speed of 26 mph as averaged over a single full hour of the year[1]. New buildings or additions to existing buildings may not cause ground-level winds to reach or exceed this wind speed for more than a single hour during the year. Exceptions pursuant to Section 309 are not permitted.

[1] The wind hazard criterion is derived from the 26 mph hourly average wind speed that would generate a 3-second gust of wind at 20 meters per second, a commonly used guideline for wind safety. The 26 mph hourly average is converted to a one-minute average of 36 mph, which is used to determine compliance with the 26 mph one-hour hazard criterion in the Planning Code. (Arens, E. *et al.,* "Developing the San Francisco Wind Ordinance and its Guidelines for Compliance," *Building and Environment*, Vol. 24, No. 4, p. 297-303, 1989.)

5. Assessment Methodology

5.1. Boundary Layer Wind Tunnel Testing

Wind tunnel testing is a well-established and robust means of assessing the pedestrian wind microclimate. It enables the wind conditions at the site to be quantified and classified in accordance with the San Francisco Planning Code Section 148 Wind Speed Criteria.

Wind is unsteady or gusty, and this 'gustiness' or turbulence depends on the site. Modelling these effects is achieved by a series of grid, barrier and floor roughness elements to create an atmospheric boundary layer that is representative of urban or open country conditions, as is appropriate.

A 1:300 scale model of the existing buildings at and surrounding the project site up to a 1,500-foot radius of the center of the site was constructed along with a scale model of the project site. Wind speed measurements at assessment locations were made using probes capable of measuring fluctuating pressure differences that are calibrated against wind speed. A system of probes running simultaneously was used to obtain results from 85 test points for the Existing Scenario, Existing Plus Project Scenario, and Existing Plus Project with Mitigation Scenario at a height corresponding to 5 feet at full scale (i.e. pedestrian height).

Measurements were taken for 16 wind directions in increments of 22.5º (0° represents the compass north). The methodology for quantifying the ground level wind microclimate of the site is outlined below:

- Measure the building-induced wind speeds at ground level in the wind tunnel;
- Combine these with wind frequency statistics derived from the old San Francisco Federal Building at 50 United Nations Plaza to obtain the expected frequency and magnitude of wind speeds at ground level; and
- Compare the results with the Planning Code Section 148 Wind Speed Criteria to the conditions around the site in each scenario.

The technical details relating to the instrumentation, measurements and analysis for the wind study are described in Appendix D.

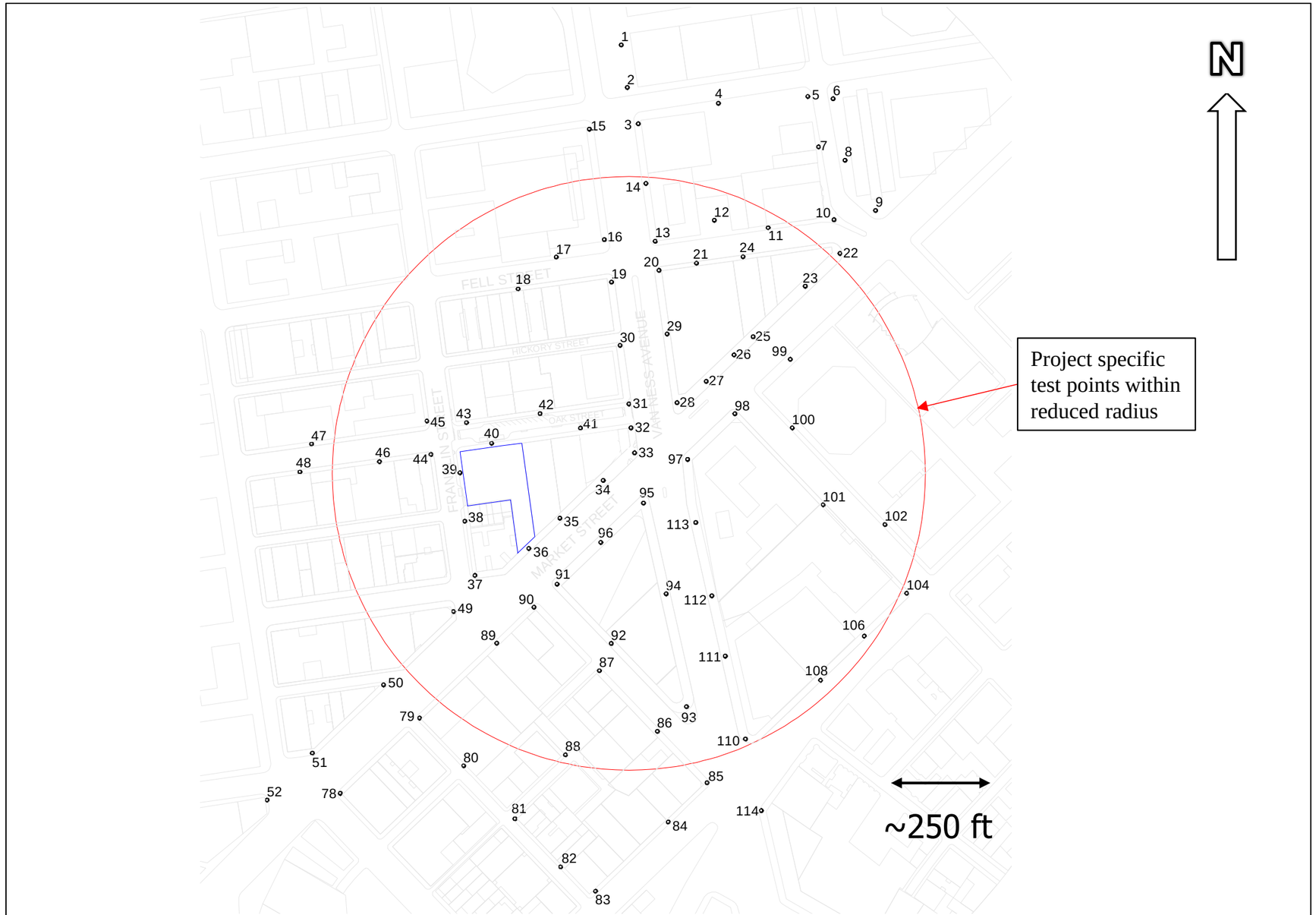
5.2. Test Points

A subset of 85 test points from the full "HUB EIR" are included in this wind tunnel test for the Existing Scenario, Existing Plus Project, and Existing Plus Project with Mitigation scenarios. The test points are selected within a 1,500-foot radius of the project site. The test points are positioned in key locations within the study area, which are the areas of pedestrian use, including the locations on the sidewalks, street

intersections as well as the open spaces. These test points have potential changes in wind speeds and turbulence levels within the development areas with the introduction of the Proposed Project.

The locations of the test points are distributed amongst study area streets as illustrated **Figure 5.1**. Additionally, a total of 58 project specific test points within a reduced coverage, approximately 700-foot radius of the project site (red circle) are selected to assess a more typical project specific scenario. The test point locations are the same for the Existing, Existing Plus Project, and Existing Plus Project with Mitigation Scenarios.

Figure 5.1: Test Point Map



432357 – 98 Franklin Test Points Map	BMT	Drawing No: 432357/FIG -5.1	By: T. Syafizan Date: July 31st, 2018

6. Wind Microclimate Results

Tables 6.1 to 6.2 show the wind comfort and hazard analysis results, respectively for:

- Existing Scenario
- Existing Plus Project Scenario
- Existing Plus Project with Mitigation Scenario

The tabular wind comfort results are expressed as the probability of exceeding the comfort 1-minute mean wind speed of 11 mph followed by the 1-minute mean wind speed that is exceeded 10% of the time. All of the points tested were on sidewalks, at corners with pedestrian crossings, or within the publicly accessible pedestrian use areas on the project site and within the relevant study area.

The tabular wind hazard results are presented as the probability of having an equivalent wind speed exceed the 26 mph mean-hourly wind speed hazard criterion for a full hour within any 1-year period, followed by the wind speed that is exceeded once per year and the number of hours that the hazard criterion of 26 mph is exceeded. As explained above in footnote 3 in subsection 4.2, the 26 mph hourly average is converted to a 1-minute mean of 36 mph, which is used to determine compliance with the 26 mph 1-hour hazard criterion in the Planning Code.

The results for the aforementioned configurations are also presented graphically as follows:

- **Figure 6.1a**: Wind comfort results for the Existing Scenario
- **Figure 6.1b**: Wind hazard results for the Existing Scenario
- **Figure 6.2a**: Wind comfort results for the Existing Plus Project Scenario
- **Figure 6.2b**: Wind hazard results for the Existing Plus Project Scenario
- **Figure 6.3a**: Wind comfort results for the Existing Plus in Mitigation Scenario
- **Figure 6.3b**: Wind hazard results for the Existing Plus in Mitigation Scenario

Table 6.1: Wind Comfort Analysis Results

Location Number	Project Specific Test Points	Comfort Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds
1	N	11	16	31%	e	16	29%	0	e	16	29%	0	e
2	N	11	19	40%	e	19	40%	0	e	19	40%	0	e
3	N	11	20	40%	e	20	39%	0	e	20	39%	0	e
4	N	11	13	18%	e	12	17%	0	e	13	18%	0	e
5	N	11	11	10%	e	11	10%	0	e	11	9%	0	-
6	N	11	24	50%	e	24	50%	0	e	24	50%	0	e
7	N	11	10	5%		9	5%	0		10	8%	1	
8	N	11	13	19%	e	13	19%	0	e	12	15%	-1	e
9	N	11	22	51%	e	22	51%	0	e	22	51%	0	e
10	N	11	25	51%	e	25	51%	0	e	25	51%	0	e
11	Y	11	14	25%	e	14	24%	0	e	15	29%	1	e
12	Y	11	18	41%	e	18	41%	0	e	18	41%	0	e
13	Y	11	28	55%	e	28	55%	0	e	28	55%	0	e
14	Y	11	10	6%		10	6%	0		11	10%	1	pp
15	N	11	16	30%	e	15	28%	0	e	15	29%	0	e
16	Y	11	16	31%	e	16	30%	0	e	16	32%	0	e
17	Y	11	11	9%		11	11%	0	p	11	10%	0	pp
18	Y	11	11	11%	e	10	7%	-1	-	10	7%	-1	-
19	Y	11	17	35%	e	17	35%	0	e	17	36%	0	e
20	Y	11	19	44%	e	19	44%	0	e	19	44%	0	e
21	Y	11	28	55%	e	28	55%	0	e	28	55%	0	e
22	N	11	17	35%	e	18	37%	0	e	17	36%	0	e
23	Y	11	12	15%	e	12	13%	-1	e	12	15%	0	e
24	Y	11	24	50%	e	24	50%	0	e	24	50%	0	e
25	Y	11	11	11%	e	11	10%	0	e	11	11%	0	e
26	Y	11	11	11%	e	12	12%	0	e	11	11%	0	e
27	Y	11	11	8%		11	9%	0		11	9%	0	
28	Y	11	17	36%	e	18	40%	1	e	18	38%	1	e
29	Y	11	20	44%	e	20	44%	0	e	20	44%	0	e
30	Y	11	18	34%	e	17	34%	0	e	18	36%	1	e
31	Y	11	12	17%	e	14	25%	2	e	12	14%	0	e
32	Y	11	11	11%	e	19	36%	7	e	15	28%	4	e
33	Y	11	11	11%	e	20	38%	9	e	17	33%	6	e
34	Y	11	13	17%	e	19	39%	6	e	18	37%	5	e
35	Y	11	9	4%		12	13%	2	p	12	13%	2	pp

Table 6.1: Wind Comfort Analysis Results (continued)

Location Number	Project Specific Test Points	Comfort Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds
36	Y	11	18	39%	e	13	20%	-4	e	14	23%	-4	e
37	Y	11	14	23%	e	23	48%	9	e	18	37%	4	e
38	Y	11	8	1%		17	35%	9	p	13	19%	5	pp
39	Y	11	12	16%	e	10	7%	-2	-	10	7%	-2	-
40	Y	11	15	30%	e	12	14%	-3	e	9	4%	-6	-
41	Y	11	18	39%	e	26	51%	9	e	15	29%	-2	e
42	Y	11	13	22%	e	16	32%	3	e	13	17%	-1	e
43	Y	11	15	30%	e	16	34%	0	e	13	18%	-3	e
44	Y	11	8	2%		16	35%	8	p	16	34%	8	pp
45	Y	11	11	10%		13	23%	3	p	14	25%	3	pp
46	N	11	11	9%		12	14%	1	p	12	16%	1	pp
47	N	11	10	5%		9	3%	-1		10	5%	0	
48	Y	11	11	8%		10	5%	-1		10	5%	-1	
49	N	11	14	20%	e	14	22%	0	e	14	21%	0	e
50	N	11	10	6%		10	8%	0		10	7%	0	
51	N	11	13	18%	e	13	19%	0	e	14	21%	1	e
52	N	11	8	2%		8	1%	0		8	2%	0	
78	N	11	12	17%	e	12	17%	0	e	13	19%	0	e
79	N	11	12	15%	e	13	18%	1	e	12	16%	0	e
80	N	11	10	7%		11	11%	1	p	11	10%	1	
81	N	11	12	15%	e	12	14%	0	e	12	14%	0	e
82	N	11	10	7%		11	8%	0		10	6%	0	
83	N	11	12	15%	e	13	17%	0	e	12	15%	0	e
84	N	11	9	4%		9	5%	0		9	2%	-1	
85	Y	11	14	24%	e	13	21%	-1	e	12	16%	-2	e
86	Y	11	12	16%	e	12	17%	0	e	12	15%	0	e
87	Y	11	13	21%	e	12	13%	-1	e	12	13%	-1	e
88	Y	11	10	5%		10	6%	0		10	6%	0	
89	Y	11	12	15%	e	13	21%	1	e	14	23%	2	e
90	Y	11	11	10%	e	15	28%	4	e	14	24%	3	e
91	Y	11	15	28%	e	15	26%	0	e	14	24%	-1	e
92	Y	11	11	9%		15	26%	5	p	15	25%	4	pp
93	Y	11	15	31%	e	15	32%	0	e	15	29%	0	e
94	Y	11	11	9%		12	15%	1	p	12	14%	1	pp
95	Y	11	11	11%	e	15	27%	4	e	15	26%	3	e

Table 6.1: Wind Comfort Analysis Results (continued)

Location Number	Project Specific Test Points	Comfort Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds	Wind Speed exceeded 10% of time[3] (mph)	Percentage of Time Wind Speed Exceeds 11 mph[3]	Speed Change Relative to Existing (mph)	Exceeds
96	Y	11	14	24%	e	18	39%	4	e	17	36%	3	e
97	Y	11	15	28%	e	15	32%	1	e	16	33%	1	e
98	Y	11	15	28%	e	17	36%	2	e	15	29%	0	e
99	Y	11	10	6%		10	4%	0		9	3%	-1	
100	Y	11	12	13%	e	13	18%	1	e	11	11%	0	e
101	Y	11	20	42%	e	17	39%	-2	e	17	39%	-2	e
102	Y	11	21	42%	e	19	41%	-1	e	19	41%	-1	e
104	N	11	19	39%	e	16	32%	-3	e	18	36%	-1	e
106	Y	11	17	34%	e	15	27%	-2	e	15	27%	-2	e
108	Y	11	12	13%	e	12	13%	0	e	12	15%	1	e
110	Y	11	19	42%	e	19	42%	0	e	19	42%	0	e
111	Y	11	8	1%		9	2%	0		9	4%	1	
112	Y	11	13	17%	e	12	17%	0	e	12	14%	-1	e
113	Y	11	12	12%	e	14	25%	3	e	14	22%	2	e
114	N	11	22	47%	e	20	43%	-2	e	20	43%	-2	e

All Test Points

Average	Average	Sum
14.2	**22%**	**64**
Existing, e		64

Average	Average	Average	Sum
15.1	**25%**	**0.9**	**71**
Existing, e			62
New, due to Existing Plus Project Scenario, p			9
Eliminated by Existing Plus Project Scenario, -			2

Average	Average	Average	Sum
14.6	**24%**	**0.4**	**69**
Existing, e			60
Existing Plus Project Scenario, p			0
New, due to Existing Plus Project Scenario, pp			9
Existing Eliminated Existing Plus Project with Mitigation Scenario, -			4
Existing Plus Project Eliminated Existing Plus Project with Mitigation Scenario, --			0

Project Specific Test Points

Average	Average	Sum
14.1	**22%**	**45**
Existing, e		45

Average	Average	Average	Sum
15.4	**27%**	**1.4**	**51**
Existing, e			43
New, due to Existing Plus Project Scenario, p			8
Eliminated by Existing Plus Project Scenario, -			2

Average	Average	Average	Sum
14.7	**25%**	**0.6**	**51**
Existing, e			42
Existing Plus Project Scenario, p			0
New, due to Existing Plus Project Scenario, pp			9
Existing Eliminated Existing Plus Project with Mitigation Scenario, -			3
Existing Plus Project Eliminated Existing Plus Project with Mitigation Scenario, --			0

[3] Year Round between 7 a.m. and 6 p.m.

Table 6.2: Wind Hazard Analysis Results

Location Number	Project Specific Test Points	Hazard Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds
1	N	36	37	1	e	35	0	-1	-	35	0	-1	-
2	N	36	44	14	e	42	12	-2	e	42	12	-2	e
3	N	36	47	19	e	44	15	-4	e	44	15	-4	e
4	N	36	24	0		23	0			24	0		
5	N	36	30	0		30	0			34	0		
6	N	36	48	43	e	48	43	0	e	48	43	0	e
7	N	36	26	0		26	0			28	0		
8	N	36	27	0		26	0			28	0		
9	N	36	43	12	e	43	12	0	e	43	12	0	e
10	N	36	49	54	e	53	53	-1	e	53	53	-1	e
11	Y	36	28	0		26	0			28	0		
12	Y	36	54	14	e	38	2	-12	e	38	2	-12	e
13	Y	36	52	119	e	52	119	0	e	52	119	0	e
14	Y	36	24	0		22	0			23	0		
15	N	36	32	0		32	0			32	0		
16	Y	36	30	0		31	0			33	0		
17	Y	36	24	0		29	0			26	0		
18	Y	36	24	0		23	0			23	0		
19	Y	36	32	0		32	0			32	0		
20	Y	36	36	1	e	36	1	0	e	36	1	0	e
21	Y	36	53	138	e	53	138	0	e	53	138	0	e
22	N	36	33	0		34	0			33	0		
23	Y	36	25	0		24	0			25	0		
24	Y	36	44	24	e	44	24	0	e	44	24	0	e
25	Y	36	32	0		32	0			32	0		
26	Y	36	34	0		35	0			36	0		
27	Y	36	32	0		34	0			34	0		
28	Y	36	32	0		35	0			34	0		
29	Y	36	38	2	e	38	2	0	e	38	2	0	e
30	Y	36	34	0		33	0			35	0		
31	Y	36	31	0		34	0			32	0		
32	Y	36	24	0		37	1	1	p	30	0		
33	Y	36	26	0		40	4	4	p	33	0		
34	Y	36	30	0		38	1	1	p	35	0		
35	Y	36	19	0		27	0			25	0		

Table 6.2: Wind Hazard Analysis Results (continued)

Location Number	Project Specific Test Points	Hazard Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds
36	Y	36	35	0		27	0			28	0		
37	Y	36	27	0		43	15	15	p	35	0		
38	Y	36	20	0		32	0			25	0		
39	Y	36	26	0		29	0			21	0		
40	Y	36	32	0		31	0			22	0		
41	Y	36	33	0		49	69	69	p	35	0		
42	Y	36	30	0		41	3	3	p	28	0		
43	Y	36	30	0		38	1	1	p	29	0		
44	Y	36	19	0		34	0			34	0		
45	Y	36	28	0		32	0			35	0		
46	N	36	24	0		25	0			27	0		
47	N	36	23	0		23	0			24	0		
48	Y	36	21	0		20	0			20	0		
49	N	36	27	0		28	0			27	0		
50	N	36	23	0		23	0			23	0		
51	N	36	25	0		25	0			26	0		
52	N	36	18	0		19	0			17	0		
78	N	36	25	0		24	0			25	0		
79	N	36	23	0		24	0			23	0		
80	N	36	19	0		21	0			21	0		
81	N	36	22	0		22	0			22	0		
82	N	36	23	0		23	0			21	0		
83	N	36	24	0		24	0			23	0		
84	N	36	21	0		20	0			20	0		
85	Y	36	26	0		25	0			24	0		
86	Y	36	26	0		26	0			26	0		
87	Y	36	24	0		24	0			24	0		
88	Y	36	20	0		20	0			20	0		
89	Y	36	24	0		25	0			25	0		
90	Y	36	21	0		29	0			26	0		
91	Y	36	29	0		29	0			28	0		
92	Y	36	22	0		31	0			30	0		
93	Y	36	31	0		29	0			30	0		
94	Y	36	25	0		25	0			25	0		
95	Y	36	22	0		28	0			27	0		

Table 6.2: Wind Hazard Analysis Results (continued)

Location Number	Project Specific Test Points	Hazard Criterion (mph)	Existing Scenario			Existing Plus Project Scenario				Existing Plus Project with Mitigation Scenario			
			Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds	Wind Speed Exceeded 1 Hour per Year (mph)	Hours per Year Wind Speed Exceeds Hazard Criterion	Hours Change Relative to Existing	Exceeds
96	Y	36	28	0		32	0			31	0		
97	Y	36	38	1	e	40	2	1	e	37	1	0	e
98	Y	36	29	0		32	0			32	0		
99	Y	36	25	0		23	0			24	0		
100	Y	36	24	0		25	0			23	0		
101	Y	36	37	1	e	35	0	-1	-	35	0	-1	-
102	Y	36	40	5	e	38	2	-3	e	38	2	-3	e
104	N	36	36	1	e	30	0	-1	-	33	0	-1	-
106	Y	36	32	0		30	0			30	0		
108	Y	36	25	0		25	0			27	0		
110	Y	36	35	0		35	0			35	0		
111	Y	36	20	0		20	0			21	0		
112	Y	36	25	0		24	0			23	0		
113	Y	36	27	0		28	0			29	0		
114	N	36	41	8	e	38	3	-5	e	38	3	-5	e

All Test Points

Average	Sum	Sum
29.7	**457**	**17**
Existing, e		17

Average	Sum	Sum	Sum
31.2	**522**	**65**	**21**
Existing, e			14
New, due to Existing Plus Project Scenario, p			7
Eliminated by Existing Plus Project Scenario, -			3

Average	Sum	Sum	Sum
30.3	**427**	**-30**	**14**
Existing, e			14
Existing Plus Project Scenario, p			0
New, due to Existing Plus Project Scenario, pp			0
Existing Eliminated Existing Plus Project with Mitigation Scenario, -			3
Existing Plus Project Eliminated Existing Plus Project with Mitigation Scenario, --			0

Project Specific Test Points

Average	Sum	Sum
29.6	**305**	**9**
Existing, e		9

Average	Sum	Sum	Sum
32.0	**384**	**79**	**15**
Existing, e			8
New, due to Existing Plus Project Scenario, p			7
Eliminated by Existing Plus Project Scenario, -			1

Average	Sum	Sum	Sum
30.6	**289**	**-16**	**8**
Existing, e			8
Existing Plus Project Scenario, p			0
New, due to Existing Plus Project Scenario, pp			0
Existing Eliminated Existing Plus Project with Mitigation Scenario, -			1
Existing Plus Project Eliminated Existing Plus Project with Mitigation Scenario, --			0

Figure 6.1a: Wind Comfort Results - Existing Scenario

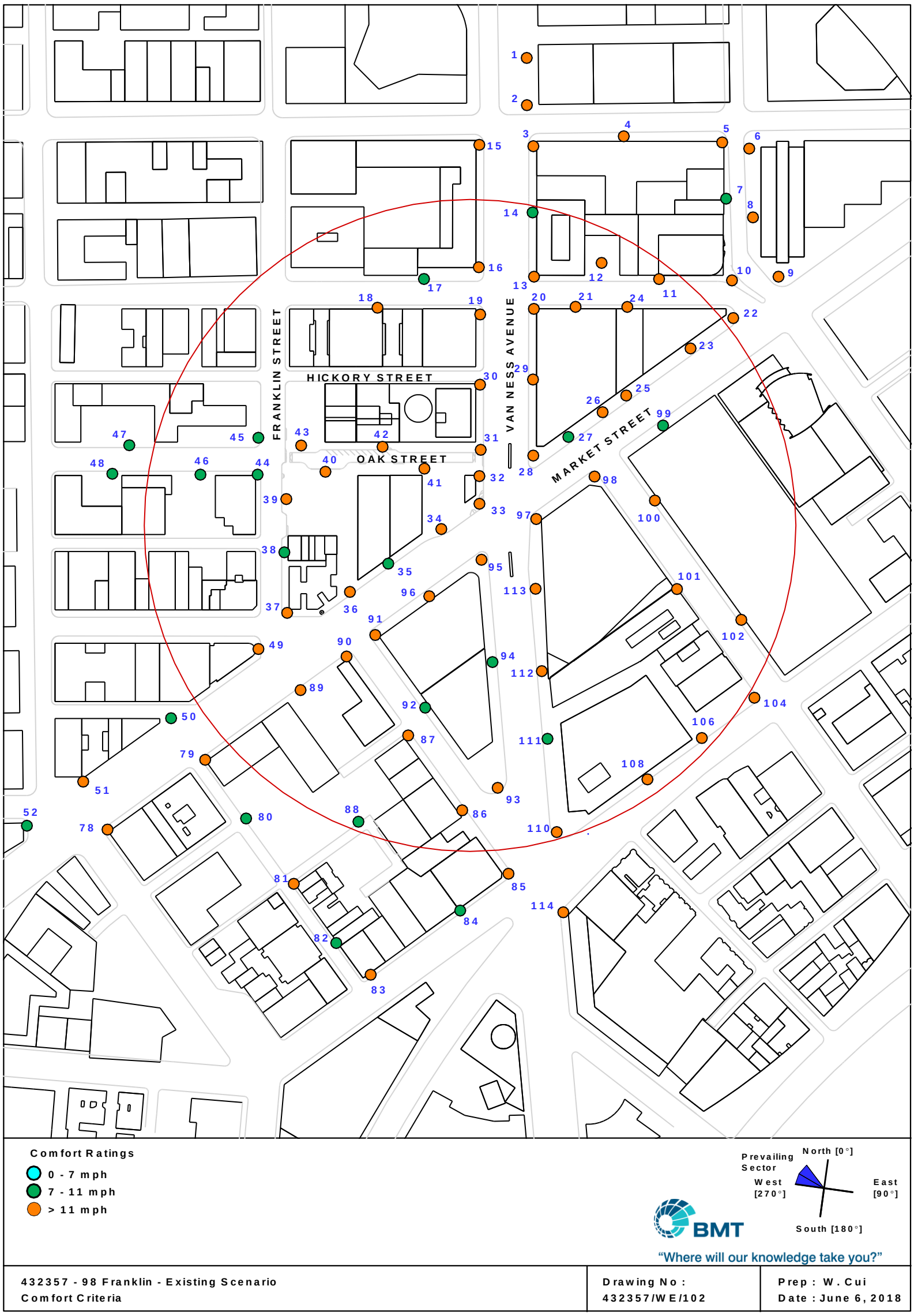


Figure 6.1b: Wind Hazard Results - Existing Scenario

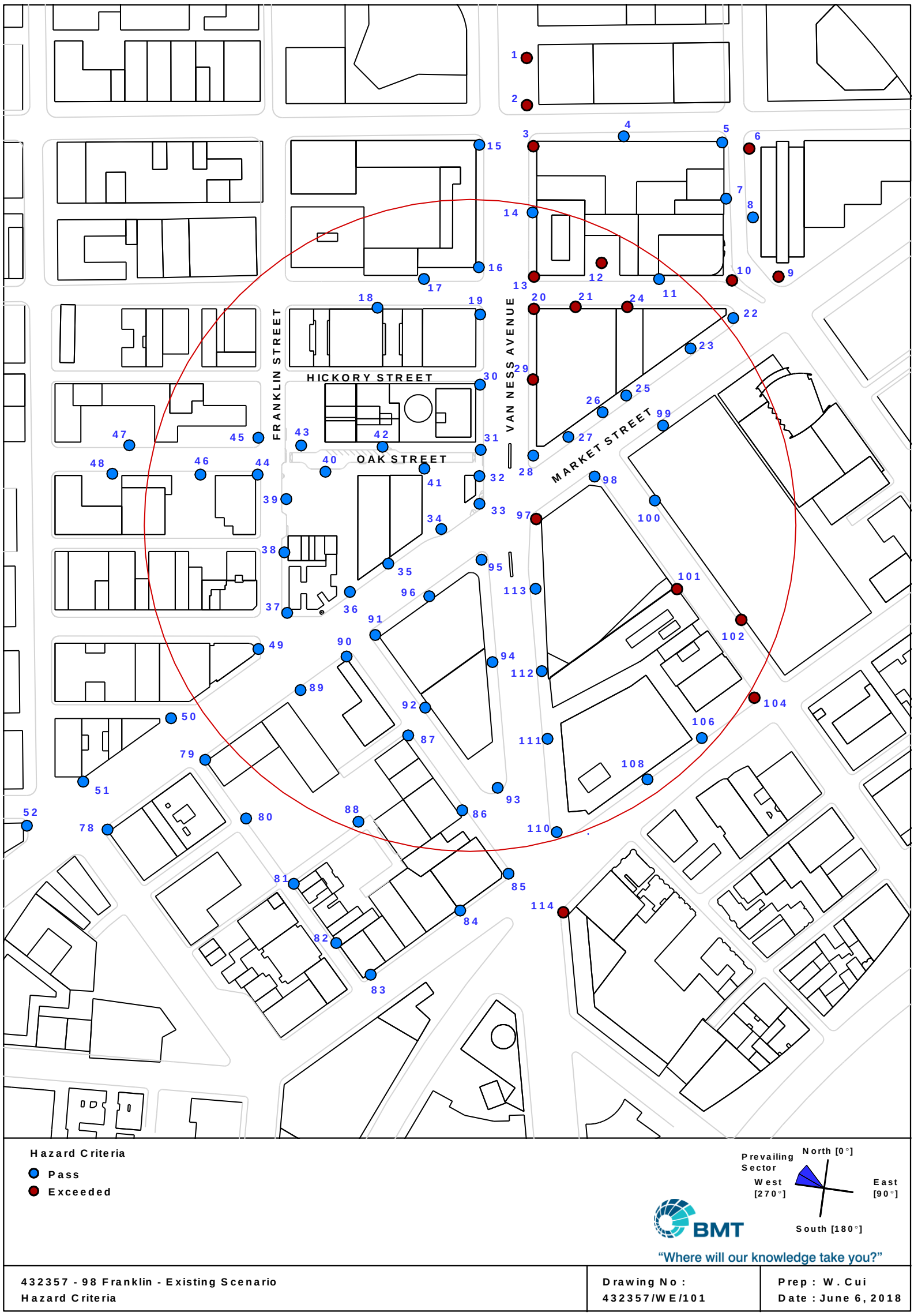


Figure 6.2a: Wind Comfort Results – Existing Plus Project Scenario

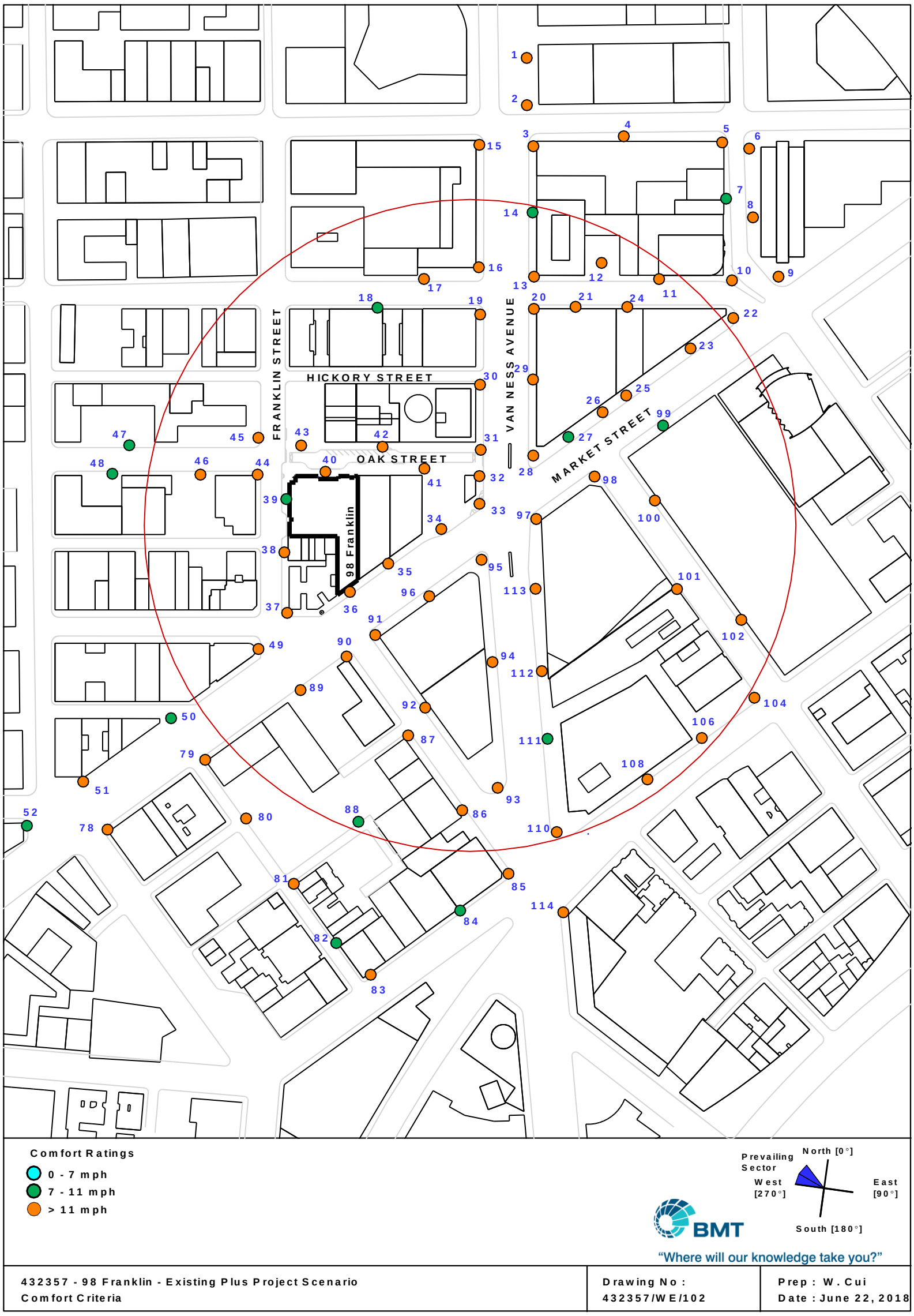


Figure 6.2b: Wind Hazard Results – Existing Plus Project Scenario

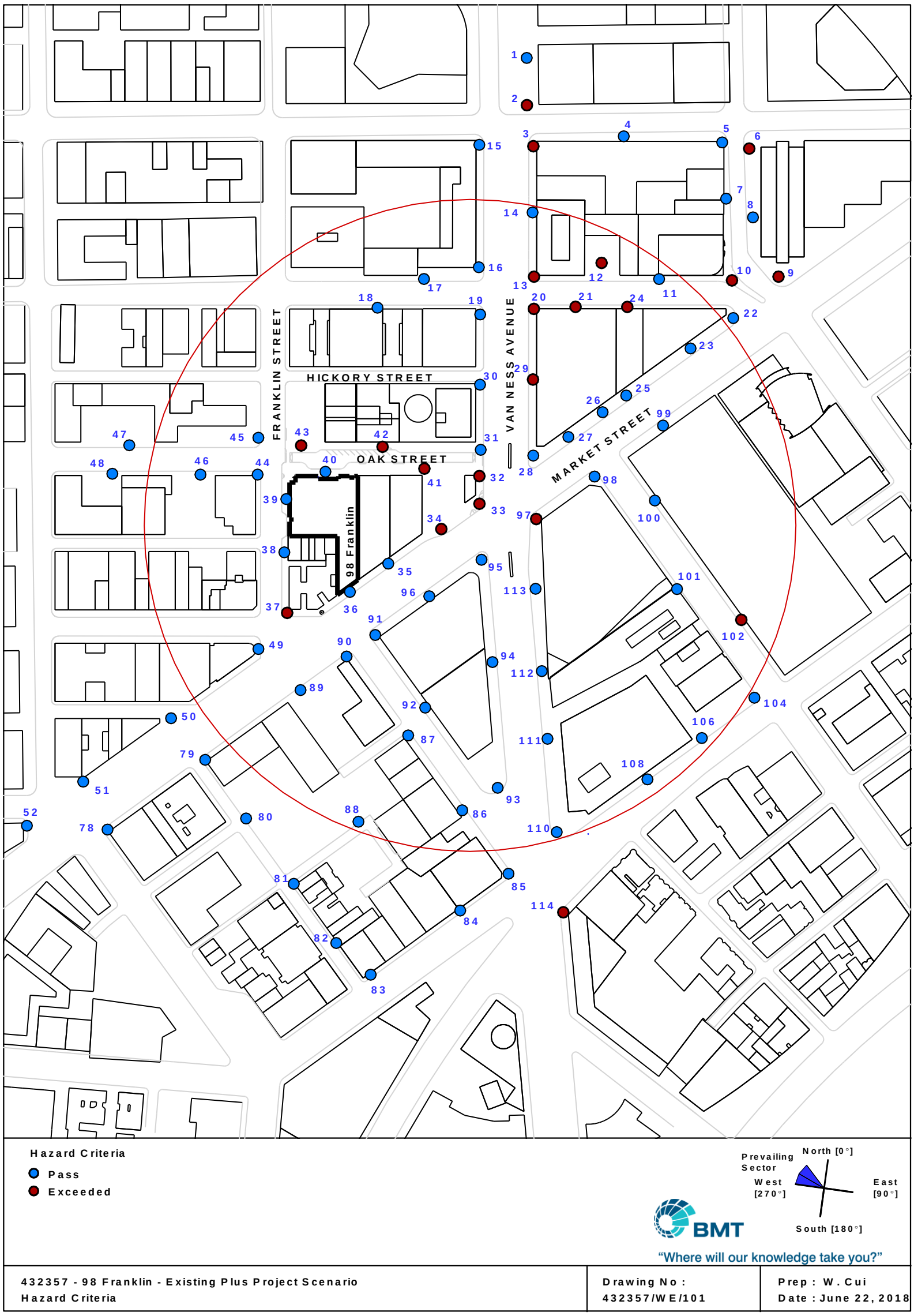


Figure 6.3a: Wind Comfort Results – Existing Plus Project with Mitigation Scenario

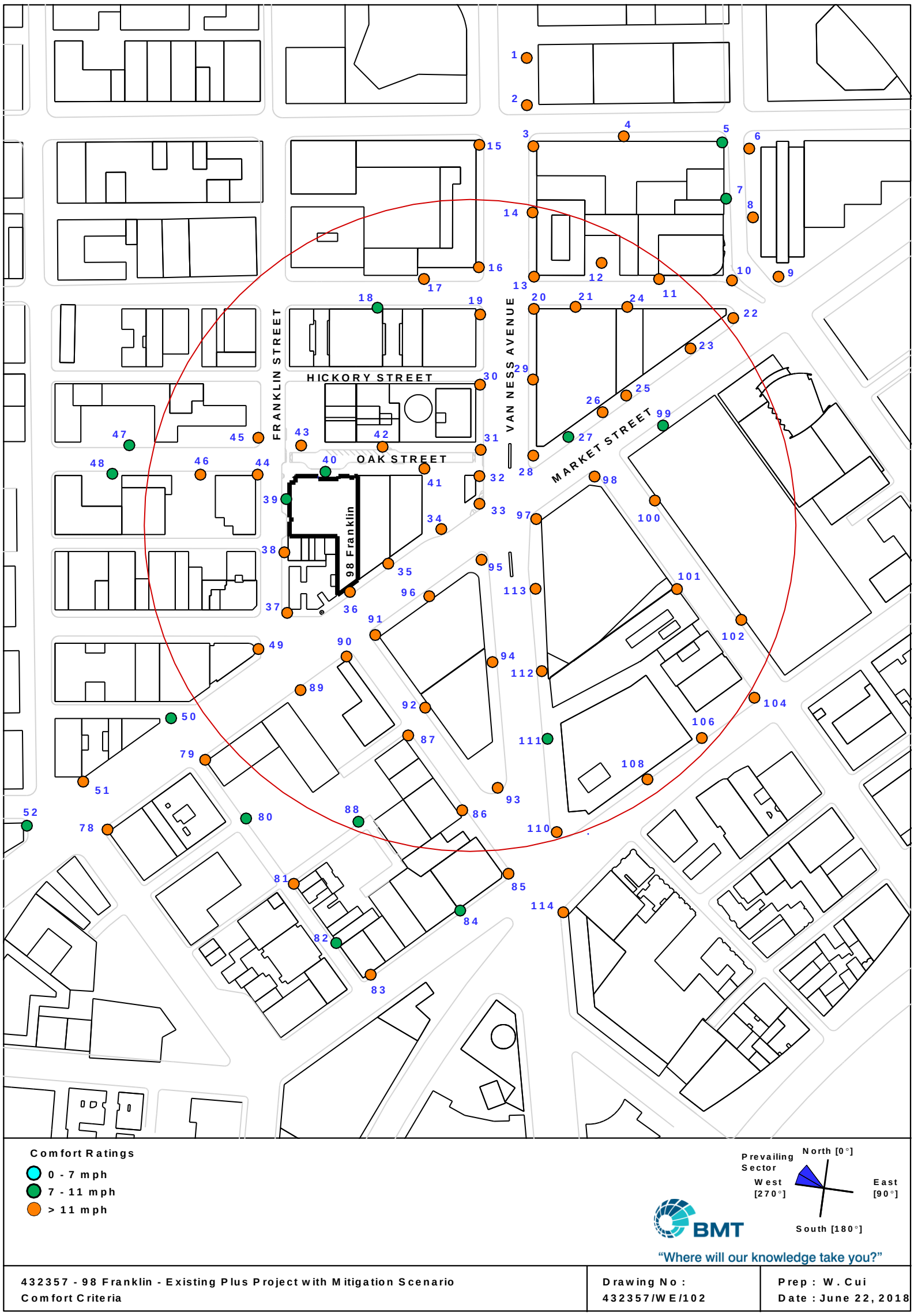
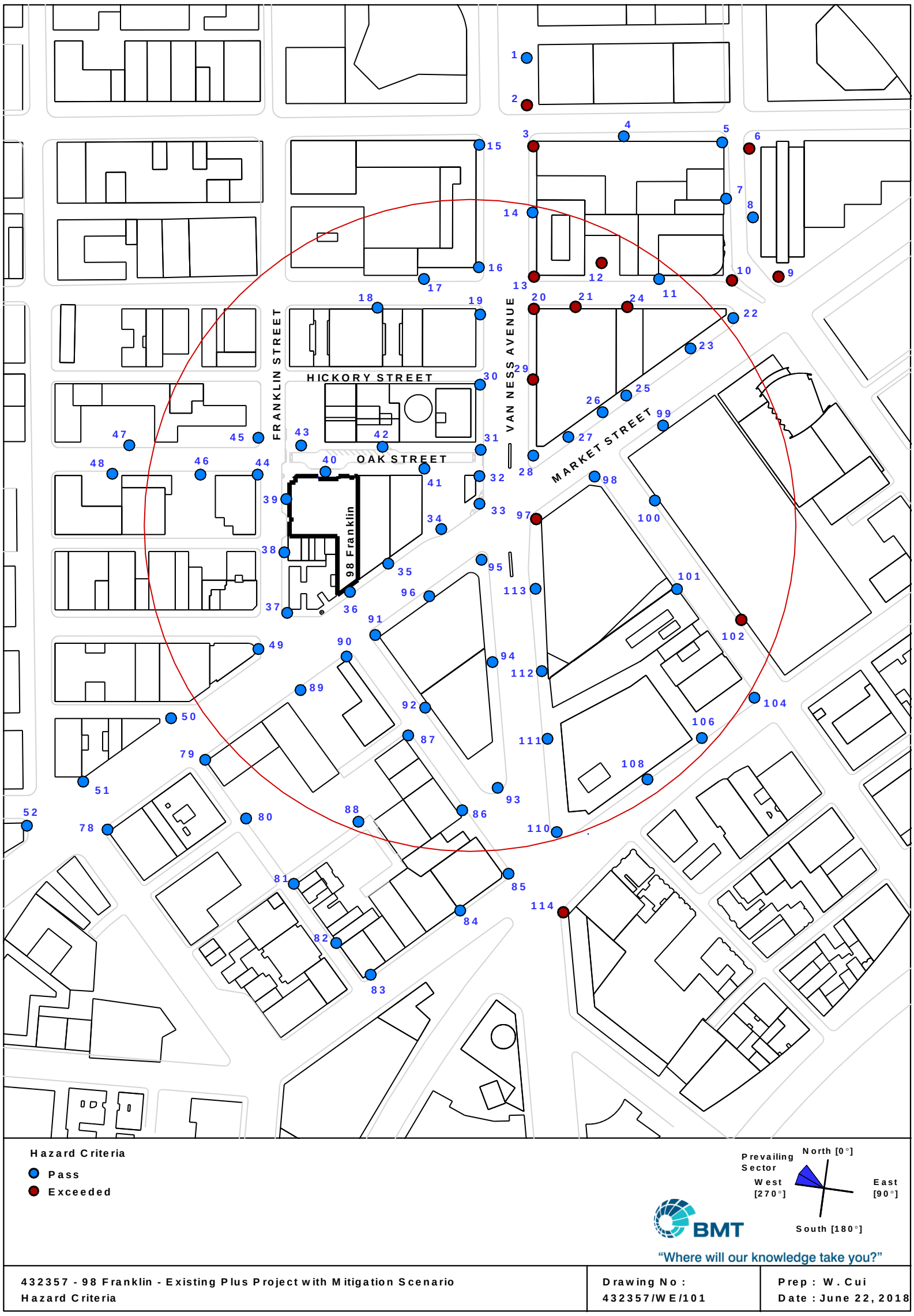


Figure 6.3b: Wind Hazard Results – Existing Plus Project with Mitigation Scenario



7. Discussion of Results

7.1. Existing Scenario

Existing wind conditions in the project site's vicinity are generally characterized as windy. The site and surroundings are subject to winds in excess of the City's comfort criteria for more than 10% of the time during the year in multiple test points. The site and surrounding study area is also prone to wind hazards at a few test points on the eastern side of the project site.

7.1.1. Wind Comfort Criterion

The study area is windy with wind conditions at 64 out of the 85 total test points exceeding the comfort criterion specified in Section 148 of the San Francisco Planning Code. The average year-round wind speed exceeded 10% of the time, between 7 a.m. and 6 p.m., for all test points is 14.2 mph, which is higher than the City's 11 mph comfort criterion for areas of pedestrian use (see **Table 6.1** and **Figure 6.1a**).

The wind conditions at 45 out of 58 the total project specific test points within the reduced radius exceeding the comfort criterion specified in Section 148 of the San Francisco Planning Code. The average year-round wind speed exceeded 10% of the time, between 7 a.m. and 6 p.m., for all test points is 14.1 mph, which is higher than the City's 11 mph comfort criterion for areas of pedestrian use.

7.1.2. Wind Hazard Criterion

Within the Existing Scenario, wind conditions exceed the hazard criterion at 17 out of 85 test points. The total number of hazard exceedance hours is 457 (see **Table 6.2** and **Figure 6.1b**). The test points at which wind conditions exceed the hazard criteria are located along the eastern sidewalk of the Van Ness Avenue (test points 1, 2, 3, 13, 20, 29, 97 and 114), along Polk Street (test point 6), along Fell Street (test points 9, 10, 12, 21 and 24) and along 11th Street (test points 101, 102, and 104).

The wind conditions at 9 out of 58 total project specific test points within the reduced radius exceeding the hazard criterion. The total number of hazard exceedance hours is 305. The test points at which wind conditions exceed the hazard criteria are located along the eastern sidewalk of the Van Ness Avenue (test points 13, 20, 29 and 97), along Fell Street (test points 12, 21 and 24) and along 11th Street (test points 101 and 102).

7.2. Existing Plus Project Scenario

The assessment indicates that for the Project Scenario located within the existing setting, wind conditions would be slightly worse in terms of wind comfort and wind hazard, compared to the Existing Scenario.

7.2.1. Wind Comfort Criterion

In terms of comfort, the average year-round wind speed, exceeded 10% of the time, between 7 a.m. and 6 p.m., for all test locations would slightly increase from 14.2 mph to 15.1 mph, which remains higher than the 11 mph comfort criterion for areas of pedestrian use. Wind conditions at a total of 71 out of 85 test points would exceed the comfort criterion for the Existing Plus Project Scenario (see **Table 6.1** and **Figure 6.2a**). The test points at which wind conditions are improved and satisfy the comfort criteria are along Fell Street (test point 18) and along Franklin Street (test point 39). However, the test points at which wind conditions exceed the comfort criteria attributable to the Project are along Fell Street (test point 17), along Market Street (test point 35), along Franklin Street (test point 38), along Oak Street (test points 44, 45, and 46), along Brady Street (test point 80), along 12th Street (test point 92) and along Van Ness Avenue (test point 94).

Wind conditions at a total of 51 out of 58 project specific test points within reduced radius would exceed the comfort criterion for the Existing Plus Project Scenario. The project specific test points within the reduced radius at which wind conditions are improved and satisfy the comfort criteria are along Fell Street (test point 18) and along Franklin Street (test point 39). However, the test points at which wind conditions exceed the comfort criteria attributable to the Project are along Franklin Street (test point 38), along Oak Street (test points 44, 45, and 46), along 12th Street (test point 92) and along Van Ness Avenue (test point 94).

7.2.2. Wind Hazard Criterion

The number of test points in which wind conditions exceed the hazard criterion would be increased from 17 in the Existing Scenario to 21 in the Existing Plus Project Scenario. Additionally, the total duration of hazardous wind conditions would be increased from 457 hours to 522 hours, representing a net increment of 65 hours of hazardous wind conditions compared to the Existing Scenario (see **Table 6.2** and **Figure 6.2b**). The test points at which wind conditions are improved and satisfy the hazard criteria are along Van Ness Avenue (test point 1) and along 11th Street (test points 101 and 104). However, the test points at which wind conditions exceed the hazard criteria attributable to the Project are along Van Ness Avenue (test points 32 and 33), along Market Street (test points 34 and 37) and along Oak Street (test points 41, 42 and 43).

The wind conditions at project specific test point within the reduced radius exceed the hazard criteria would be increased from 9 in the Existing Scenario to 15 in the Existing Plus Project Scenario. The total duration of hazardous wind conditions would be increased from 305 hours to 384 hours, representing a net increment of 79 hours of hazardous wind conditions compared to Existing Scenario. The project specific test points within the reduced radius at which wind conditions are improved and satisfy the hazard criteria is along 11th Street (test point 101). However, the project specific test points within the reduced radius at which wind conditions exceed the hazard

criteria attributable to the Project are along Van Ness Avenue (test points 32 and 33), along Market Street (test points 34 and 37) and along Oak Street (test points 41, 42 and 43).

7.3. Existing Plus Project with Mitigation Scenario

The assessment indicates that in the Existing Plus Project with Mitigation Scenario wind conditions would be better compared to the Existing and Existing Plus Project Scenario. The proposed trees and canopy shield pedestrians from downdrafts caused by the Project, reducing pedestrian level winds and creating a more favorable wind microclimate near the Project.

7.3.1. Wind Comfort Criterion

Within the Existing Plus Project with Mitigation Scenario, wind conditions would exceed the comfort criterion at 69 out of 85 test points, which would represent a net decrement of 2 test points compared to the Existing Plus Project Scenario (see **Table 6.1** and **Figure 6.3a**). The test points at which wind conditions are improved and satisfy the comfort criteria are along Hayes Street (test point 5), along Oak Street (test point 40) and along Brady Street (test point 80). However, the test point at which wind conditions exceed the comfort criteria is along Van Ness Avenue (test point 14).

Wind conditions at a total of 51 out of 58 project specific test points within reduced radius would exceed the comfort criterion for the Existing Plus Project with Mitigation Scenario. The project specific test point within the reduced radius at which wind conditions exceed the comfort criteria attributable to the Project is along Van Ness Avenue (test point 14).

7.3.2. Wind Hazard Criterion

The number of test points in which wind conditions exceed the hazard criterion would be decreased from 17 in the Existing Scenario to 14 in the Existing Plus Project with Mitigation Scenario. The total duration of hazardous wind conditions would be decreased from 457 hours to 427 hours, representing a net decrement of 30 hours of hazardous wind conditions compared to Existing Scenario.

The wind conditions at project specific test points within the reduced radius exceed the hazard criteria would be decreased from 9 in the Existing Scenario to 8 in the Existing Plus Project with Mitigation Scenario. The total duration of hazardous wind conditions would be decreased from 305 hours to 289 hours, representing a net decrement of 16 hours of hazardous wind conditions compared to Existing Scenario.

8. Conclusions

The boundary layer wind tunnel study has assessed the wind microclimate in the 98 Franklin Street study area. On the basis of the wind tunnel modelling, the following conclusions have been drawn:

- Within the Existing Scenario, wind conditions exceed the comfort criterion at 64 out of 85 test points, with a combined average hourly wind speed of 14.2 mph. Under the Existing Scenario, wind conditions exceed the hazard criterion at 17 out of 85 test points, which collectively exceed the hazard criterion for a duration of 457 hours annually.

- Within the Existing Plus Project Scenario, wind conditions would exceed the comfort criterion at 71 out of 85 test points, which would represent a net increment of 7 test points compared to Existing Scenario. The average wind speed over all the test points would be increased from 14.2 mph in the Existing Scenario to 15.1 mph in the Existing Plus Project Scenario. The number of test points in which wind conditions exceed the hazard criterion would be increased from 17 in the Existing Scenario to 21 in the Existing Plus Project Scenario. Additionally, the total duration of hazardous wind conditions would be increased from 457 hours to 522 hours, representing a net increment of 65 hours of hazardous wind conditions compared to the Existing Scenario.

- Wind mitigation measures have been developed, which comprise of evergreen trees along Oak Street and Franklin Street and a canopy along Franklin Street. Further details of the mitigation measures are provided in **Figure D.5.**

- Within the Existing Plus Project with Mitigation Scenario, wind conditions would exceed the comfort criterion at 69 out of 85 test points, which would represent a net decrement of 2 test points compared to the Existing Plus Project Scenario. The number of test points in which wind conditions exceed the hazard criterion would be decreased from 17 in the Existing Scenario to 14 in the Existing Plus Project with Mitigation Scenario. The total duration of hazardous wind conditions would be decreased from 457 hours to 427 hours, representing a net decrement of 30 hours of hazardous wind conditions compared to the Existing Scenario.

Appendix A 98 Franklin Scope of Work

BMT is pleased to submit this scope of work to perform a wind study for pedestrian comfort as well as to assess the potential for pedestrian wind hazards for the Proposed Project, herein referred to as the "Project". The following includes our understanding of the Project and the San Francisco Planning Department's requirements. Our proposed work plan and schedule to perform each task for the wind study are below

Project Understanding

The 23,753-square-foot project site is located on the block bounded by Market Street to the south, Franklin Street to the west, Oak Street to the north, and Van Ness Avenue to the east in the Civic/Downtown neighborhood, and within the C-3-G (Downtown-General) District and Van Ness and Market Downtown Residential Special Use District (Van Ness and Market Downtown Residential SUD). The project site is currently developed with a surface parking lot, which provides 135 vehicle parking spaces and fronts on Franklin, Market, and Oak streets. The proposed project would remove the parking lot and construct a 380-foot-tall, mixed-use building approximately 469,100 square feet in size. The proposed project would include 75,000 square feet of institutional space for the French American International School (on levels 1- 5 including 30-40 classrooms), 345 dwelling units, 3,100 square feet of commercial/retail space (within two ground-level storefronts), and 29,117 square feet of vehicle parking (within two basement levels). The proposed development would be part of the existing French American International School (FAIS) campus, which is currently located at 150 Oak Street, about one block northwest of the project site.

Proposed Work Plan

Task #1: Test Definition and Test Plan

BMT will define and present an adequate test plan to the San Francisco Planning Department staff for their review and approval, after review of the plans and consulting with SOM Architects, if necessary (the architects and project sponsors shall not direct any wind consultant work), and work with them to resolve any questions with the plan. The test plan will identify the locations of the test points and the buildings to be included in each scenario. The three scenarios to be customarily tested are the Existing Scenario, Project Scenario and Project with Mitigation Scenario.

Task #2: Model Construction

BMT will construct a 1:300 scale model of the Project using high density foam based upon design information provided by the project architects. BMT will also construct an existing context model of the surrounding buildings upwards to a radial distance of 1,500 feet, to properly simulate the existing winds in the project vicinity. The buildings falling outside the radial distance of 1,500 feet are relatively distant from the project, thus the project unlikely makes a noticeable impact to the wind conditions around the areas beyond 1,500 feet from the project.

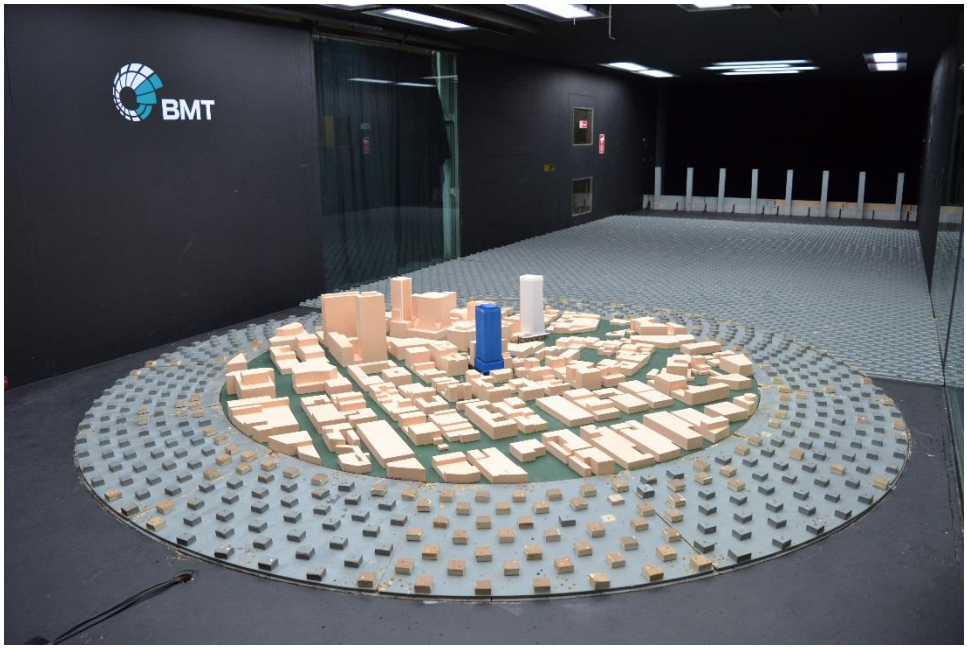
Task #3: Wind Tunnel Tests

BMT will conduct wind tunnel testing for 16 wind directions (in increments of 22.5 degrees) at all test point locations for each of the three scenarios, namely: 3a) the existing condition, including buildings currently under construction; 3b) the proposed project in the existing surrounding condition; 3c) the proposed project with mitigation in the existing surrounding conditions.

The actual composition and setup of the wind tunnel models for the three scenarios and each individual wind direction will be based on the expert judgement of the wind tunnel technical staff of BMT, as part of developing the Test Plan (Task #1).

The existing condition will include all of the existing buildings in and around the Proposed Project development site. An example of the wind tunnel model covering the existing developments is given in **Figure A.1**.

Figure A.1: Wind tunnel model covering existing developments



Task #4: Test Data Analysis / Evaluation / Wind Test Report

The testing, data reduction and evaluation will conform to protocols and requirements for such wind- tunnel tests for buildings in San Francisco. BMT, in collaboration with Related, will prepare a Technical Memorandum for submittal to the Planning Department, in order to report the findings of the wind tunnel test for the three scenarios. The final version of the report will address all comments and edits from the City's Planning Department.

The methodology for quantifying the pedestrian-level wind microclimate of the site is outlined below:

- Measure the building-induced wind speeds at pedestrian level in the wind tunnel;
- Combine these with wind frequency statistics derived from the old San Francisco Federal Building at 50 United Nations Plaza to obtain the expected frequency and magnitude of wind speeds at pedestrian level; and
- Compare the results with the San Francisco Planning Code Section 148 Wind Speed Criteria to the conditions around the site.

The wind tunnel data will be output measuring two specific conditions: potential for the project (in three test scenarios) to exceed the hazard criterion; as well as potential for the project to exceed the comfort criterion. Both sets of results will be presented in the Technical Memorandum. The wind hazard results will be presented as the probability of having a wind speed exceed the 26-mph equivalent wind speed hazard criterion for a full hour within any one-year period followed by the wind speed that is exceeded once per year and the number of hours that the hazard criterion of 26-mph is exceeded. The wind comfort results will be given as the probability of having the comfort equivalent wind speed of 11-mph exceeded followed by the equivalent wind speed that is exceeded 10% of the time.

Appendix B San Francisco Planning Code Section 148

B.1. Reduction of Ground Level Wind Currents

1. ***Requirement***: New buildings and additions to existing buildings shall be shaped, or other wind-baffling measures shall be adopted, so that the developments would not cause ground-level wind currents to exceed, more than 10 percent of the time year-round, between 7:00 am and 6:00 pm, the comfort level of 11 mph equivalent wind speed in areas of substantial pedestrian use and seven mph equivalent wind speed in public seating areas. The term "***equivalent*** wind speed" shall mean the wind speed adjusted to incorporate the effects of gustiness or turbulence on pedestrians.

2. When pre-existing ambient wind speeds exceed the comfort level, or when a proposed building or addition may cause ambient wind speeds to exceed the comfort level, the building shall be designed to reduce the ambient wind speeds to meet the requirements.

3. ***Exception:*** The Zoning Administrator may allow the building or addition to add to the amount of time the comfort level is exceeded by the least practical amount if (i) it can be shown that a building or addition cannot be shaped and other wind- baffling measures cannot be adopted to meet the foregoing requirements without creating an unattractive and ungainly building form and without unduly restricting the development potential of the project site in question, and (ii) ***the*** Zoning Administrator concludes that, because of the limited amount by which the comfort level is exceeded, the addition is insubstantial. The Zoning Administrator shall not grant an exception, and, no building or addition shall be permitted that causes equivalent winds speeds to reach or exceed the hazard level of 26 miles per hour for a single hour of the year.

4. ***Procedures:*** Procedures and methods for implementing this Section shall be specified by the Environmental Review Officer of the Planning Department.

Appendix C Quality Assurance

BMT is an accredited boundary layer wind tunnel testing facility and computational flow modelling organization. BMT holds certification for quality assurance of wind engineering services to ISO 9001:2008.

The team assigned to this work will be highly dedicated to achieving a successful project. The team is experienced at providing a fully integrated and collaborative approach to the working stream.

The Technical Director together with the three acting Line Managers will hold overall responsibility for the works on the project. The Project Manager will have responsibility for the direct management of the project including planning, monitoring progress, and final reporting. They will liaise with the client on all aspects of the project.

The project team is supported by an experienced group of dedicated specialists such as instrumentation engineers, wind tunnel operators, CAD specialists, and model makers.

Each and every member of the team has considerable experience in relation to wind environment testing for numerous developments across the globe ranging from masterplans to high-rise buildings to large-span roof structures.

For the all works completed standardized technical procedures are applied.

Appendix D Wind Tunnel & Model Details

D.1. Wind Tunnel Specifications

All the tests were conducted in BMT's Boundary Layer Wind Tunnel which has a test section 15.7-foot wide, 7.9-foot high and 49.2-foot long with a 14.4-foot diameter multiple plate turntable and a remotely controlled 3-dimensional traversing system. The operating wind speed range is 0.45 – 100.7mph.

The turbulent boundary layer is set up using an arrangement of roughness elements distributed over the floor of the wind tunnel, vertical posts and a 2D barrier placed at the entrance to the test section according to the upwind fetch.

D.2. Model

D.2.1. Information

The models of the proposed development were constructed based on 3D drawing information supplied by the project sponsor and the project architects. The wind tunnel models representative of the surrounding building morphology was constructed by BMT based on information provided by the project architects and the San Francisco Planning Department, in conjunction with a BMT site survey. The models were reviewed and approved by the design team, prior to testing.

D.2.2. Scale

A model scale of 1:300 has been adopted. At this scale the model is large enough to allow a good representation of the details that are likely to affect the local and overall wind flows at full scale. In addition, this scale enables a good simulation of the turbulence properties of the wind to be achieved.

D.2.3. Construction

The surrounding buildings are represented by high-density foam blocks to a sufficient level of detail to reproduce the wind flows at the location of the Proposed Project. The model is mounted on a 9.8-foot diameter baseboard and installed on the 14.4-foot diameter large turntable of BMT's Boundary Layer Wind Tunnel. In the region beyond the detailed surrounds model, the terrain is modelled as generalized roughness.

D.2.4. Model Photos

Images of the wind tunnel model are presented as follows:

- **Figures D.1** and **D.2** - Existing Scenario
- **Figures D.3** and **D.4** - Existing Plus Project Scenario
- **Figures D.5** - Wind Mitigation Measures

Figure D.1: Existing Scenario (Close-up), Viewed from Northwest

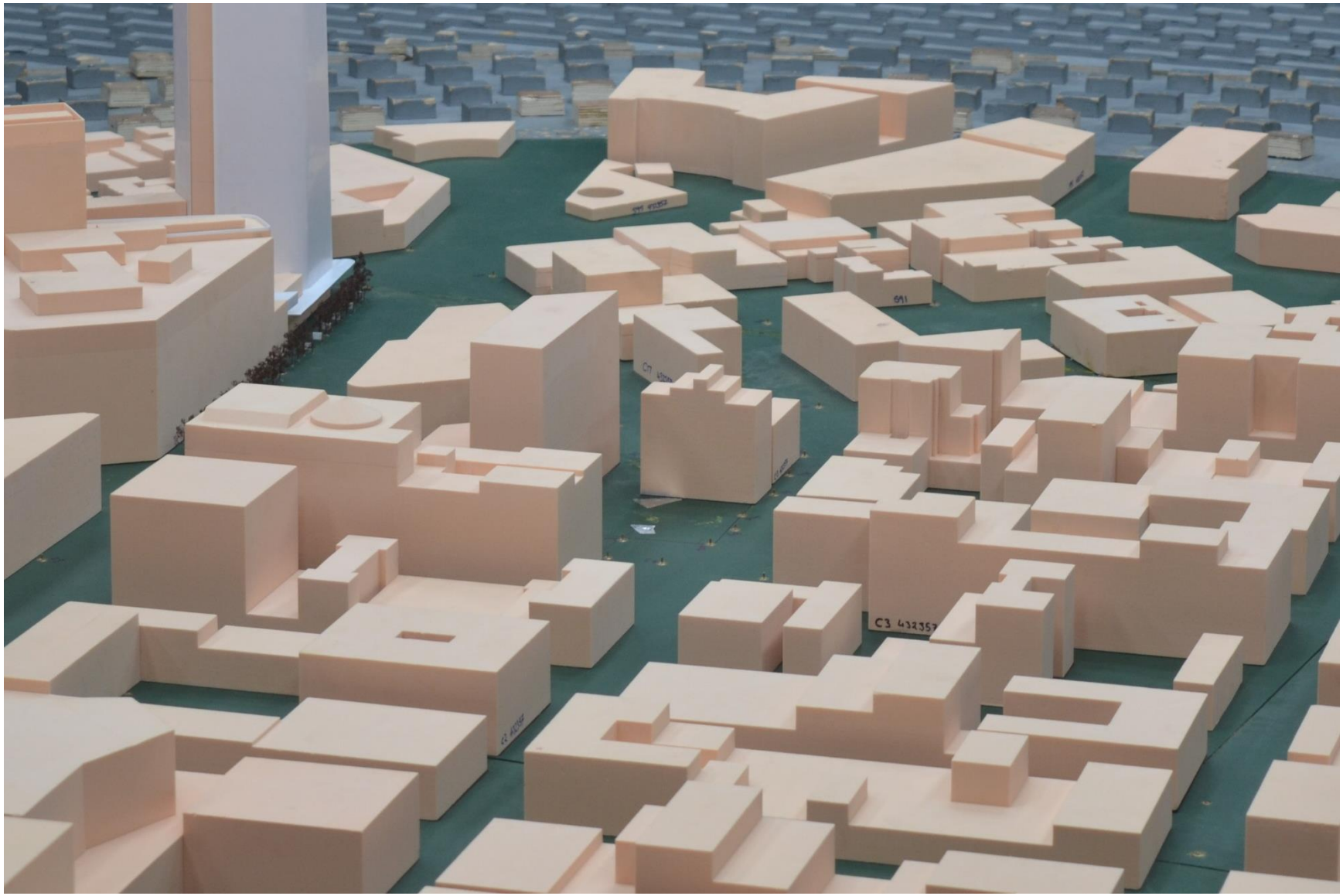


Figure D.2: Existing Scenario, Wind Tunnel Setup, Viewed from Southeast

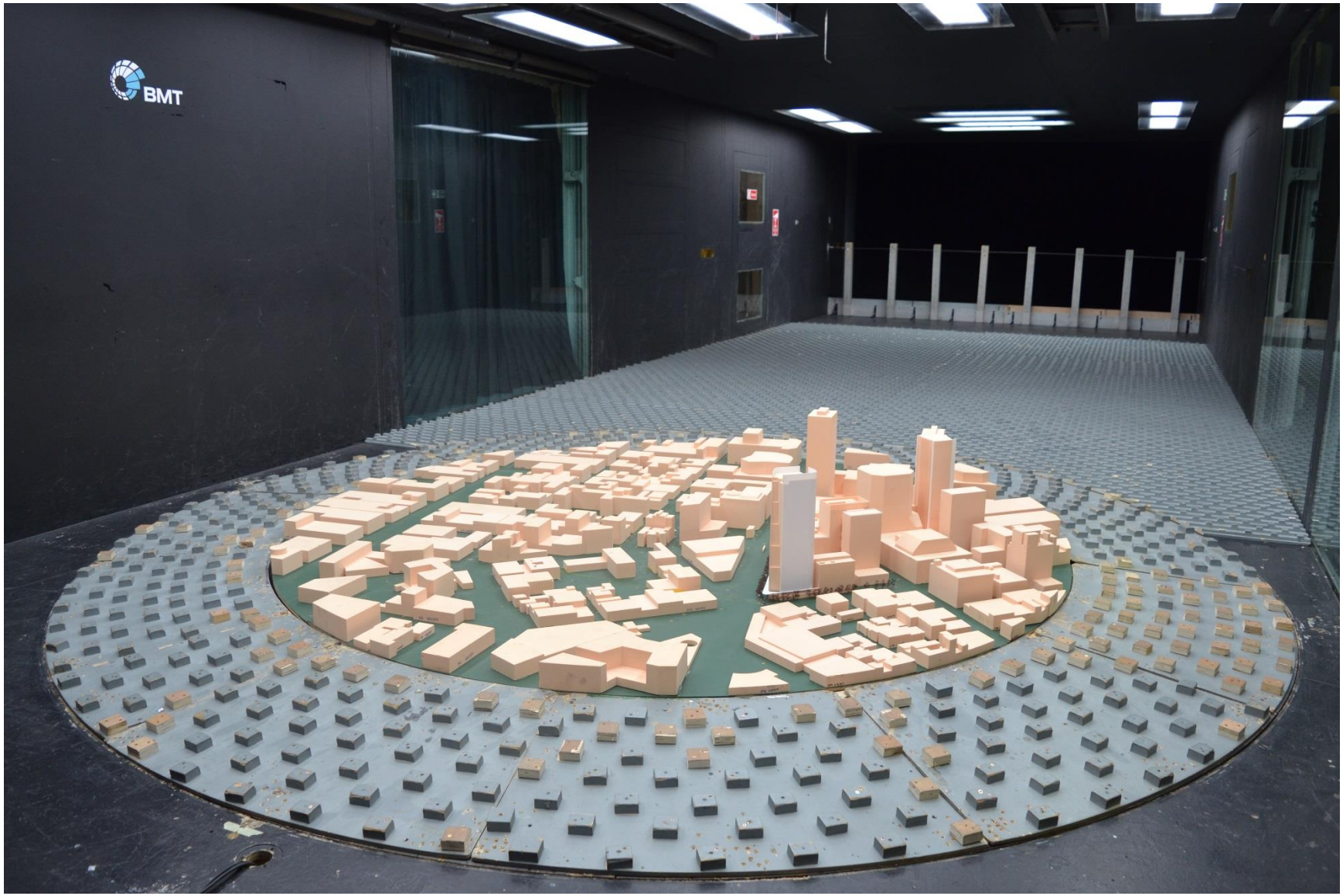


Figure D.3: Existing Plus Project Scenario (Close-up), Viewed from Northwest

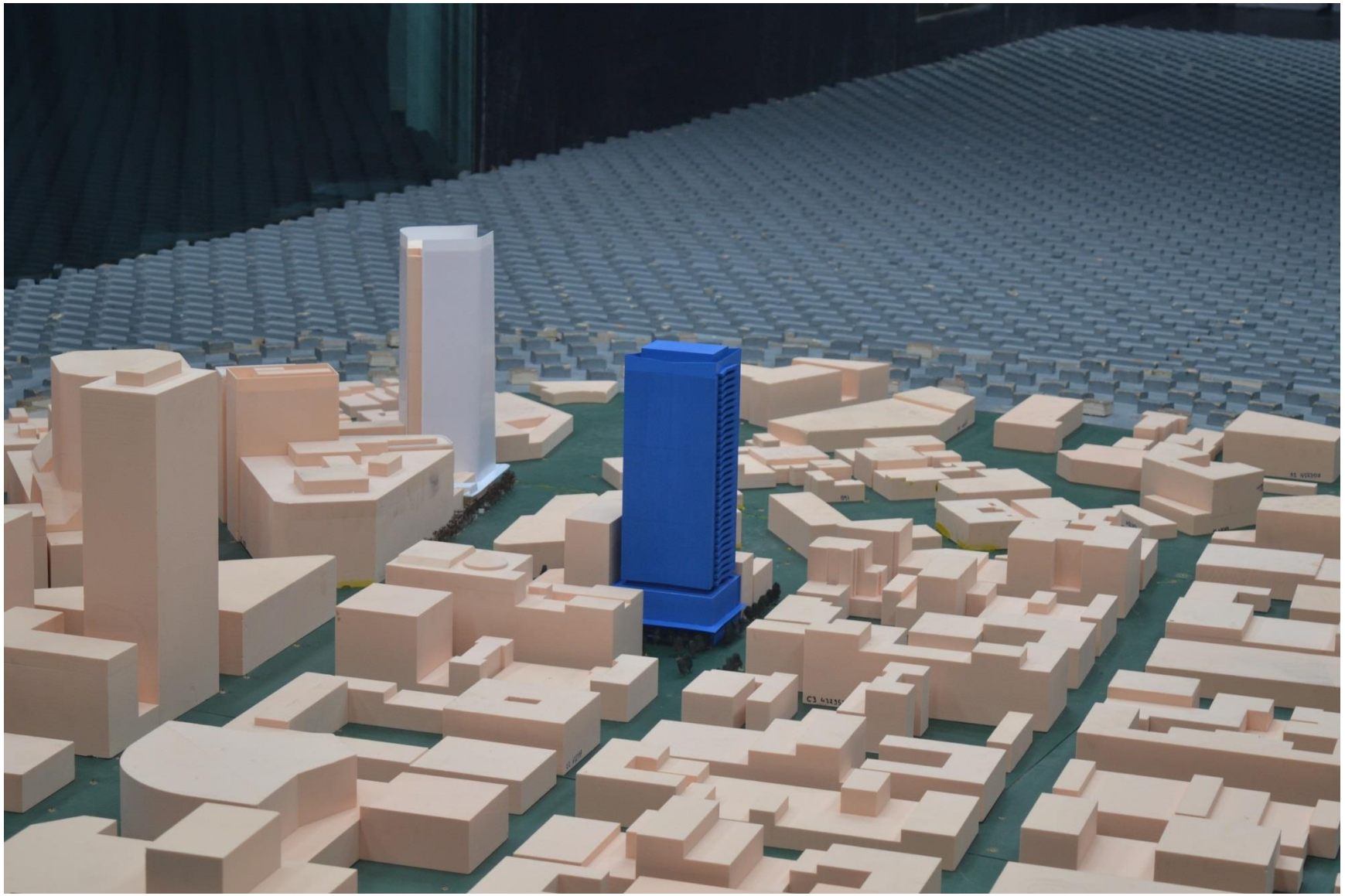


Figure D.4: Existing Plus Project Scenario, Viewed from Northeast

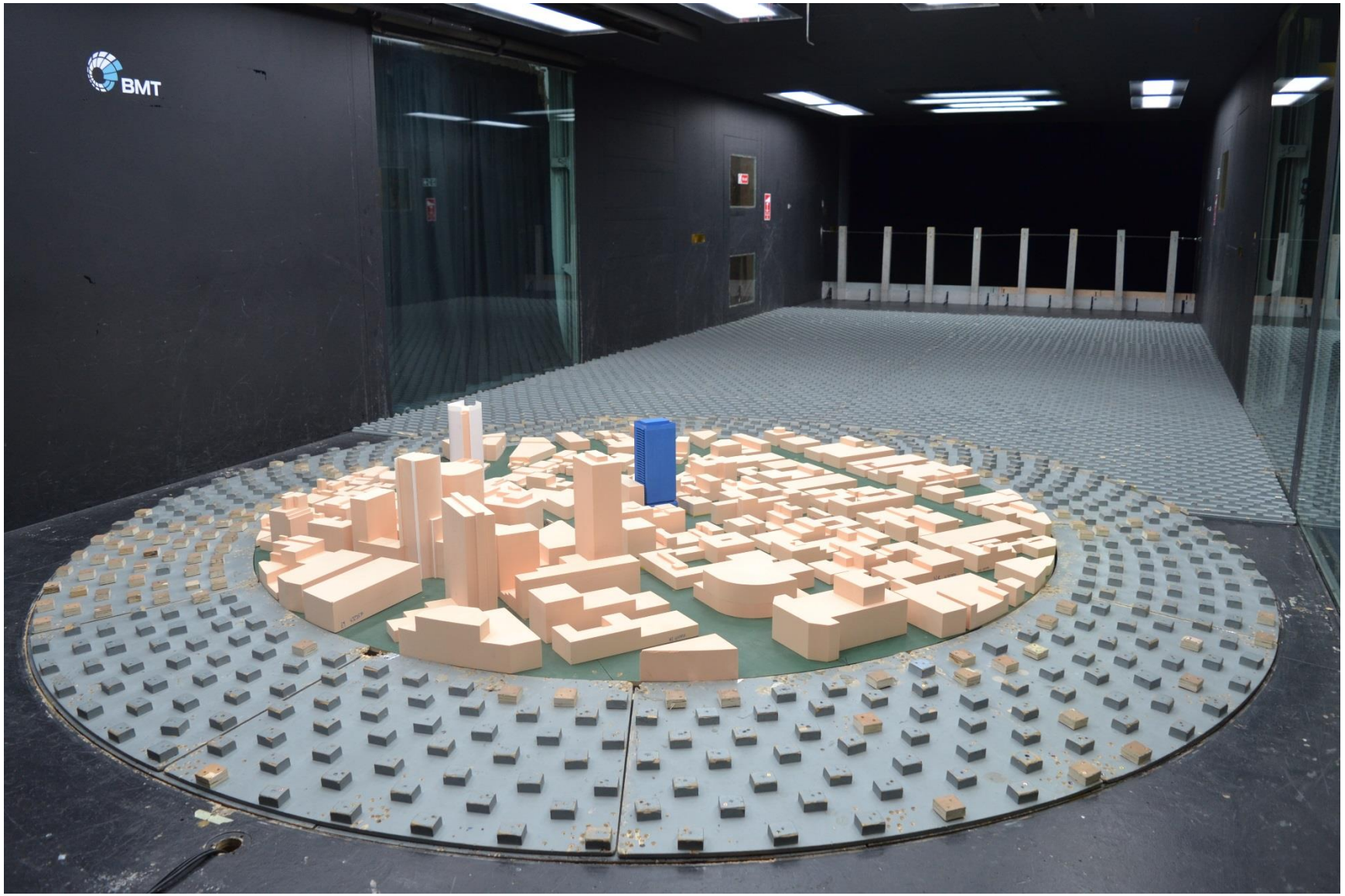
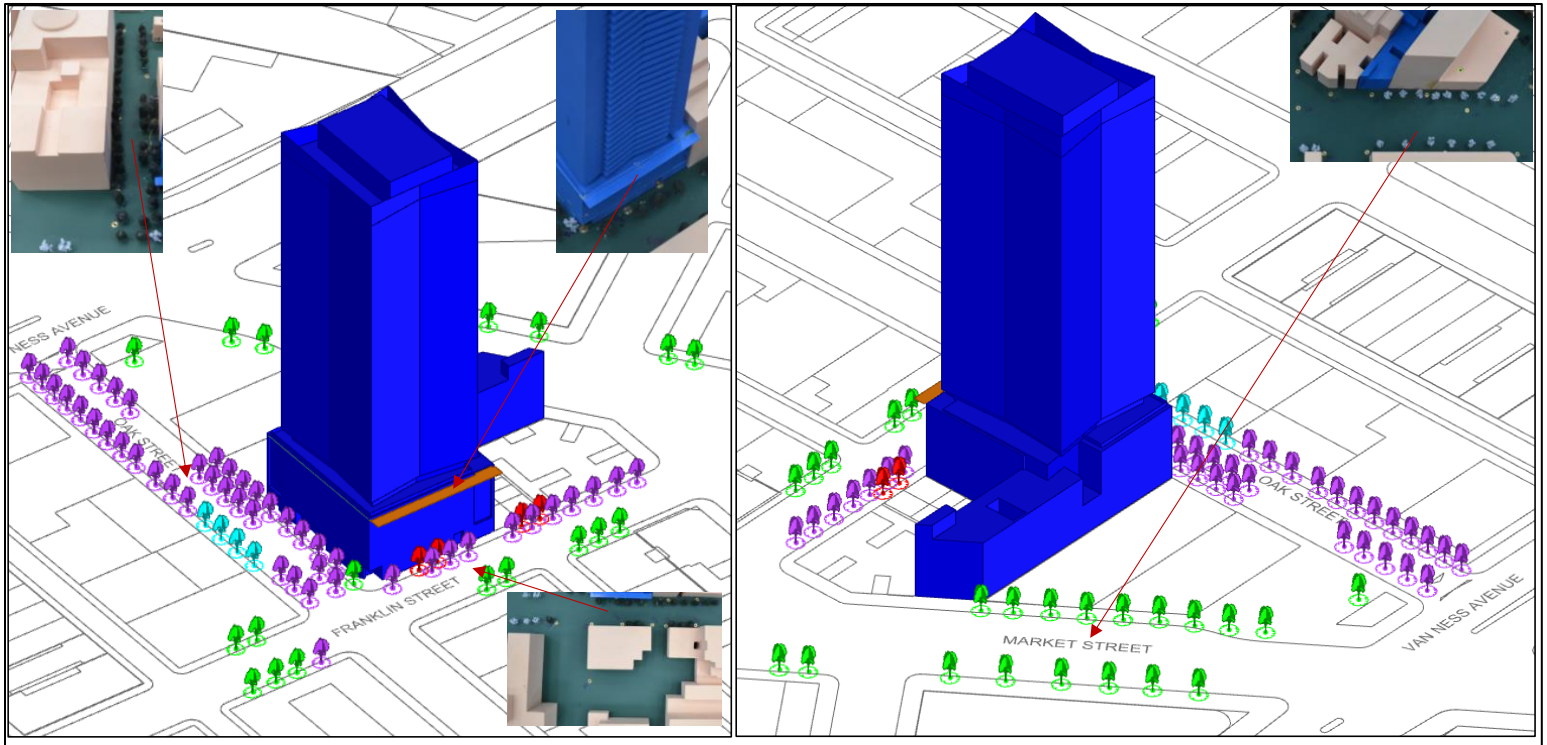
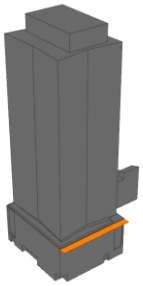


Figure D.5: Wind Mitigation Measures





– ~11ft (width) x ~126ft (length) x ~68ft (height) Canopy (option 6B)

– 25ft evergreen project trees

– Existing trees to be replaced by 25ft evergreen project trees

– Existing trees

– Existing trees to be removed

432357 – 98 Franklin Wind Mitigation Measures	BMT	Drawing No: 432357/FIG -C.5	By: T. Syafizan Date: July 31st, 2018

Appendix E Measurements and Analysis

E.1. Physical Measurements

Wind speed measurements were made using so-called 'Irwin probes', capable of measuring fluctuating pressure differences that are calibrated against wind speed. All the probes were calibrated to an accuracy of within 2 percent before the test procedure was begun. A system of probes running simultaneously was used to obtain results from the 85 test points at a height corresponding to approximately 5 feet at full scale.

The wind velocity scale (ratio of model scale velocity to full scale velocity) of the wind tunnel test was 1/1, where the frequency scale (ratio of model scale frequency to full scale frequency) was 1/300. The freestream wind speed of the test was approximately 50mph. The data was sampled at a full-scale frequency of 5 samples per second at full scale which corresponds to 600Hz at model scale. Data were recorded for 49 seconds at model scale (245 minutes at full scale) for each wind direction to determine the mean and gust wind speeds. The turbulence intensity was derived based on the measured mean and standard deviation of the wind speeds.

The ratio between the measured wind speeds at a height of 5 feet above the surface level and the wind speed at the reference height, namely the "wind speed- up ratio", was derived from each of the Irwin measurement, at each wind direction. The wind speed- up ratios are usually less than 1, as the speed of the lowest part of an air mass is slowed down when the air moves across the buildings.

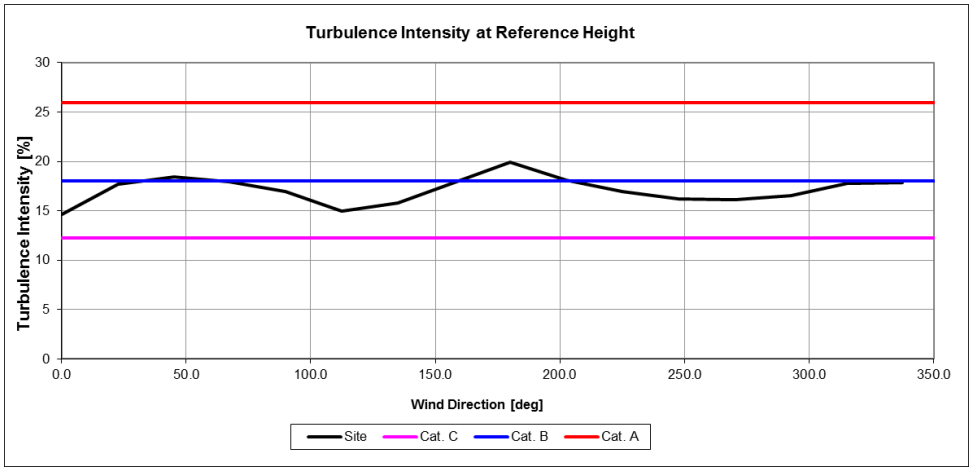
For each location, the wind speed-up ratio at each wind direction combines with the wind statistics measured in the old San Francisco Federal Building at 50 United Nations Plaza. The summation of the combined results of wind speed-up ratios and wind statistics for all wind directions are used to access the wind conditions in terms of the exceedance of threshold wind speeds that relate to hazard and comfort levels defined in the Planning Code Section 148.

E.2. Wind Properties at Project Site

A detailed wind analysis was carried out to determine the wind properties at the Proposed Project site. The wind analysis is based on the widely accepted Deaves and Harris log law wind model of the atmospheric boundary layer, as defined in ESDU (Engineering Sciences Data Unit) Item 01008 and has provided wind profiles describing the variation of wind speed and turbulence intensity with height for the wind directions on interest. From this analysis representative profiles were defined as targets for the atmospheric boundary layer simulation in the wind tunnel.

Figure E.1 shows the variation of longitudinal turbulence intensity with wind direction at the reference height of 384ft.

Figure E.1: Variation of Turbulence Intensity with Wind Direction at 384ft Height, Including Reference Turbulence Levels



Due to the variation of wind properties with wind direction, two target profiles have been selected for the boundary layer simulation.

The target profiles and range of wind angles for each wind tunnel profile are as follows:

Profile	Wind Angle Range	Target Angle
Fetch 1	0°, 90° to 135°, 225 to 292.5°	270°
Fetch 2	22.5° to 67.5°, 157.5° to 202.5°, 315° to	60°

Figures E.2a and **E.2b** present the variation of mean wind speed, longitudinal turbulence intensity and gust wind speed used in the tests. The wind speed profiles are normalized by the mean wind speed at the reference height of 384ft.

Figure E.2a: Mean Wind Speed ($U_{mean}/U_{mean(Ref)}$), Longitudinal Turbulence Intensity Profiles (I_u) and Gust Wind Speed ($U_{gust}/U_{mean(Ref)}$) Modelled in the Study (Exposure 1)

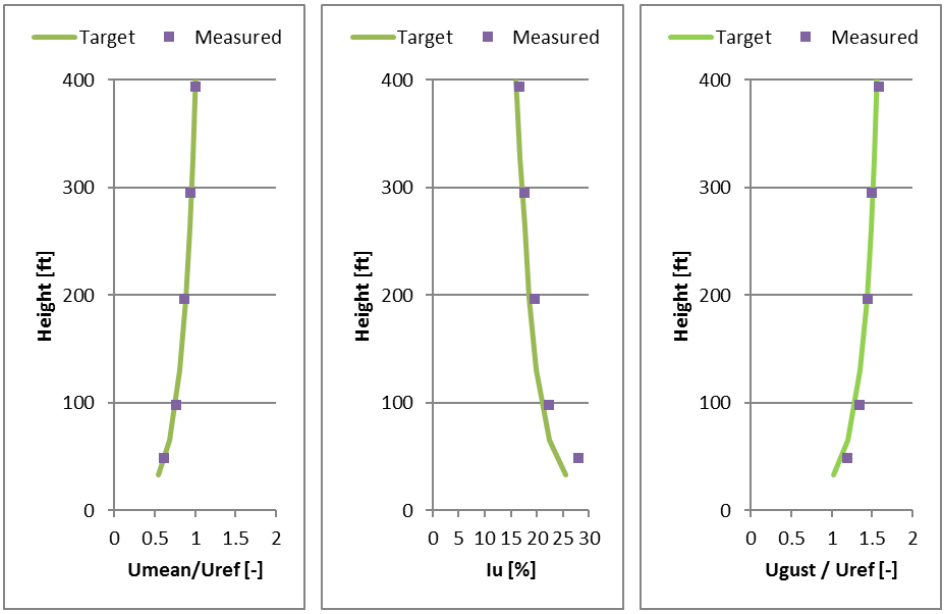
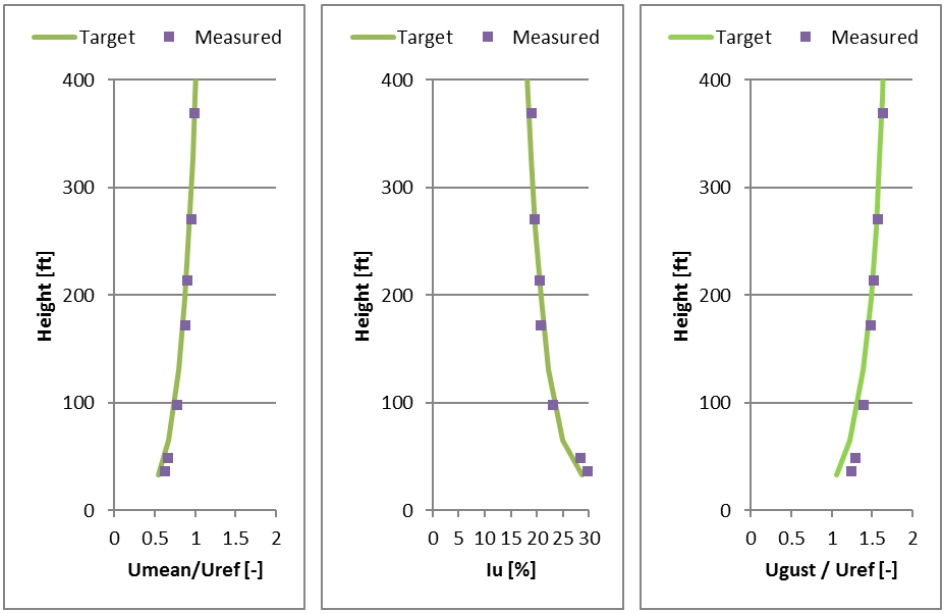


Figure E.2b: Mean Wind Speed ($U_{mean}/U_{mean(Ref)}$), Longitudinal Turbulence Intensity Profiles (I_u) and Gust Wind Speed ($U_{gust}/U_{mean(Ref)}$) Modelled in the Study (Exposure 2)



APPENDIX G-7
98 FRANKLIN STREET WIND STUDY MEMORANDUM

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Alana Callagy
San Francisco Planning Department
1650 Mission Street #400
San Francisco, CA 94103

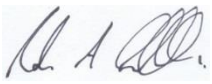
98 Franklin – Pedestrian Wind Microclimate

Dear Alana,

I am writing in connection with the recent notification received by BMT that confirms some minor changes to the height and position of the Tower. We understand that the key changes are the increase to the Tower height by 5 feet, and a minor shift (less than 5 feet) of the tower north and west on the podium.

Overall, from the perspective of the building's performance with respect to wind, these changes are minor and if made, the wind microclimate around the base of the tower would be expected to be materially the same. Therefore, the revised tower design would not materially affect the results of the 98 Franklin Wind Microclimate Study for the approved Project (Case No. 2016-014802PPA) and the shifted tower design would not result in a substantial change to the test results presented in the wind tunnel report for the 98 Franklin Street project (BMT Report 432357rep1v5, dated February 8th, 2019).

Yours sincerely,



Dr Robin Stanfield
Head of Wind Engineering