Appendix K: Pedestrian Wind Assessment

REPORT

PEDESTRIAN WIND ASSESSMENT
WESTERN RAIL YARD DEVELOPMENT
NEW YORK, NEW YORK

CONSULTING ENGINEERS
& SCIENTISTS

Project Number: #0940081 **May 12, 2009**

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EXECUTIVE SUMMARY

Issue: The objective of this assessment was to evaluate the anticipated pedestrian wind conditions, specifically wind safety, on and around the study site of the proposed Western Rail Yard development.

Approach: A qualitative assessment of the pedestrian wind conditions was conducted by RWDI using the proposed building massing and computer-based wind simulation techniques combined with the regional wind climate. A review of wind data, quantitative wind tunnel test results for other developments studied by RWDI, and our extensive experience were used to characterize the predicted wind conditions relative to other locations in Manhattan.

Existing Conditions: The existing low-rise buildings on the Western Rail Yard site do not significantly influence the wind patterns on the site, resulting in a low potential for exceeding the wind safety criterion.

No-Build Configuration: The addition of the future development east of 11th Avenue and other future buildings will have minimal effect on the wind patterns on the Western Rail Yard site for the prevailing wind directions, resulting in a low potential for the wind safety criterion being exceeded on the site.

Full-Build Configuration: An increase in wind activity on the Western Rail Yard site will occur with the addition of the proposed Western Rail Yard development, resulting in a potential for exceeding the wind safety criterion for several on-site areas. This potential ranges from low to high, depending on the nature of the local wind flows. These areas are described in detail in Section 5 of this report. Overall, the wind safety conditions are comparable to, and within the range of other similar developments along West Manhattan due to the same exposure to the prevailing northwest winds. The proposed development's slender building masses with open spaces towards the site's west edge are positive design concepts for wind effects at grade.

Mitigation: Mitigation has been recommended and is described as concepts that range from building massing changes to the provision of hard and soft landscaping features. The potential level of exceeding the wind safety criterion dictated the degree of mitigation required. These mitigation concepts have been described in Section 5 and summarized in Section 6 of this report.

1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by AKRF, Inc. to conduct a Pedestrian Wind Assessment for the proposed Western Rail Yard development in New York, New York. The objective of this qualitative analysis is to estimate the pedestrian wind conditions on and around the proposed development in terms of wind safety. Using building massing information provided by AKRF, Inc. and received by RWDI on March 18, March 23 and April 1, 2009, the current assessment is based on:

- review of regional long-term meteorological data and site and surrounding information;
- our extensive experience of wind tunnel modeling of similar developments;
- our knowledge of wind flows around buildings and engineering judgment;
- use of a program developed by RWDI (*WindEstimator*[1,2]) for estimating the potential wind conditions around generalized building forms;
- use of *Virtualwind*™, proprietary Computational Fluid Dynamics (CFD) software for visualizing wind flow patterns; and,
- reviewing RWDI wind tunnel test results for various projects, including sites in New York.

In the absence of wind tunnel testing, this screening-level modeling approach identifies areas of accelerated wind speeds and areas of relative calm that can be used for an initial qualitative estimate of pedestrian wind conditions (i.e., comfort and safety). Physical scale model testing in a boundary-layer wind tunnel can be conducted to quantify these estimates and to develop wind control measures should the wind activity warrant. Wind tunnel testing would be appropriate for a more advanced design stage of the building concepts.

1 H. Wu., C.J. Williams, H.A. Baker and W.F. Waechter (2004). "Knowledge-based Desk-Top Analysis of Pedestrian Wind Conditions". *ASCE Structure Congress 2004*. Nashville, Tennessee.

2 C.J. Williams, H. Wu., W.F. Waechter and H.A. Baker (1999). "Experience with Remedial Solutions to Control Pedestrian Wind Problems". *10th International Conference on Wind Engineering*. Copenhagen, Denmark.

This assessment was conducted for the following three configurations:

- **Existing:** The existing buildings on and around the Western Rail Yard site;
- **No-Build:** The existing buildings on-site and off-site, with future surrounding developments in place; and,
- **Full-Build:** The existing and future surroundings, with the proposed Western Rail Yard development in place.

2. SITE INFORMATION

An orientation plan of the study area is included in Figure 1 for the Full-Build Configuration.

The proposed development is bordered by 11th Avenue and 12th Avenue to the east and west, and by W 30th Street and W 33rd Street to the south and north, and is located along the east side of the Hudson River. The development consists of multiple mid and high-rise towers as illustrated in the Orientation Plan (Figure 1). The general surroundings further afield include tall, dense buildings located to the east, southeast and northeast (Manhattan) with suburban areas well beyond, and also mid-rise to high-rise to the south.

In the following discussion, references to building locations relate to “Project North” as shown in Figure 1, while the wind directions are referenced to “True North”. These differ by approximately 30°. Figures 2a through 2c show the 3-D models of the Existing, No-Build and Full-Build Configurations used in the computer-based wind simulations.

3. APPROACH

This section highlights the main components involved in the approach to estimate the wind safety conditions around the proposed Western Rail Yard. It was necessary to first determine the critical wind directions for this region as they apply to the location of the study site in Manhattan. The focus of this qualitative assessment was on pedestrian wind safety; hence, emphasis was placed on identifying and evaluating conditions associated with strong winds, versus considering all wind speeds. The latter approach is used during detailed, quantitative wind tunnel studies of pedestrian wind conditions. With the critical test directions identified, Computational Fluid Dynamics techniques (using *Virtualwind*™) were applied to analyse the flows from these wind directions and identify areas where accelerated wind flows would occur.

To augment locating the critical wind speed areas, a proprietary modeling tool (*WindEstimator*) was used to assess the buildings in simplified block forms for all wind directions. A final determination of the expected wind conditions around the site with respect to wind safety criterion was based on a review of these analyses and applying RWDI's 35+ years of experience in wind tunnel testing over 1500 projects for pedestrian wind comfort and safety, with over 30 sites located on Manhattan. A characterization of the Western Rail Yard's predicted wind conditions in comparison to other recognizable locations on Manhattan was made based on our past experience and knowledge of the general wind flow patterns at this area of Manhattan. The various qualitative analysis methods and tools available to assess wind conditions ultimately guide the professional whose interpretation through practical experience in building aerodynamics is the most essential part of the analysis.

3.1 Meteorological Data

Three long-term sources of hourly wind data for the New York City area were obtained from the National Weather Service for analysis and consideration in this assessment. These sites include wind recording stations at the John F. Kennedy, Newark and LaGuardia International Airports between 1948 and 2005. The position of the study site relative to these three airports is shown in Figure 3. Newark Airport is located approximately 10 miles to the southwest of the Western Rail Yard, La Guardia Airport is approximately 7 miles to the east-northeast and JFK Airport is approximately 14 miles to the southeast. Wind roses for strong winds (exceeding 20 mph at the airport anemometer) that occur on an annual basis for each of the three airports are shown in Figure 4. Strong winds are emphasized in view of this assessment's focus on pedestrian wind safety, and it is the stronger wind speeds that have the greatest potential to cause wind safety problems at grade.

The top left wind rose (Newark) indicates that strong winds from all directions occur for 7.6% of the time annually. Wind from the northwest occurs nearly 2% of the time at Newark Airport. The northwest winds also occur most frequently at La Guardia (top right wind rose) and JFK (bottom wind rose). The purpose of these wind roses is to illustrate the "regional" trend in the wind directions associated most often with strong wind speeds. Overall, the topography in the overall region is not significant enough to influence the general wind patterns or trends. However, there would be local speed up effects in areas on the east side of the Hudson River, where the terrain rises quickly above the height of the river, such as encountered further north on the west shore of Manhattan. The overall trend of strong winds in this region is that they originate from the west through northwest. La Guardia data indicates increased occurrence of northeast and south winds while JFK data exhibits a stronger focus on wind from the south. Considering the distance and varied make-up of building heights and terrain that lie between the study site and these historical wind data sites, no single airport was considered to provide wind conditions (i.e., speed, direction and exposure) that would be representative of the study site. Similar to techniques commonly used in wind tunnel studies to determine wind loads for buildings in Manhattan, the wind records from the three airport weather stations were combined to provide a composite set of wind data for this region.

The composite wind data were further analysed for the "summer" (May through October) and "winter" (November through April) seasons. Figure 5 graphically depicts the distribution of wind frequency and directionality for these two "six month" seasons, which are aligned with the pedestrian wind criteria used for two decades by RWDI. The upper-left wind rose identifies the summer wind data when considering all wind speeds. Overall, wind from the south and southwest prevails in this season. The lower-left wind rose shows the winter data, indicating the predominant winds from the northwest through west directions during this season. Calm winds occur 2.1% of the time in the summer and 1.8% of the time in the winter. These wind roses reflect the prevailing winds or those people experience a majority of the time throughout the year.

Figure 5 also depicts the directionality of strong winds using the composite data set. Strong winds occur for 5.3% and 15.2% of the time during the summer and winter seasons, respectively. In this region, strong winds from the northwest and south directions occur often during the summer, while northwest, west-northwest and west directions are more evident during the winter. Considering that strong winds occur approximately three times more frequently during the winter (i.e., 15.2% vs. 5.3%) emphasis in this assessment was placed on winds blowing from the northwest quadrant, followed by southerly (summertime) winds. The winds approaching the west side of Manhattan, across the Hudson River will be generally similar, resulting in comparable wind conditions along the length of the shore due to exposure to these winds. Changes in local wind patterns from site-to-site are primarily due to the influence of building massing.

3.2 Computer Wind Flow Simulations

To determine where accelerated wind flows could be expected around the proposed Western Rail Yard for the strong wind directions, *Virtualwind*^{TM}, a computational fluid dynamics (CFD) technique was used to analyze wind flows from the northwest, west and south directions. The west-northwest wind direction was not tested as wind conditions can be inferred through interpretation and comparison of the wind simulations for the west and northwest winds. For a qualitative assessment of wind conditions at a master planning level, it is appropriate to test a limited number of key wind directions with emphasis on the strongest and/or prevailing winds. Once detailed quantitative results are required, then wind tunnel testing methods using 36 wind angles is essential.

The results of the computer wind flow analyses are summarized as contours of wind speed at the pedestrian-level around the development, and represent the average wind speed for the selected directions. The simulation technique accounts for the fluctuation of turbulent flow similar to the atmospheric boundary-layer, which is also a requirement of the American Society of Civil Engineers (ASCE) for wind tunnel testing of physical scale models. Computer modeling of wind flows around substantive areas does not account for all the intricacies of wind flows derived through wind tunnel testing. However, the flow patterns and wind conditions obtained through boundary-layer computer modeling techniques do provide significant insight into areas of accelerated winds or relative calm, and also identify the nature of the wind flows associated with those conditions. This detailed flow information also provides guidance into appropriate conceptual forms of mitigation.

The computer wind simulation results illustrated in Figures 6, 7 and 8 will be discussed in the results section. However, to assist in understanding this stage of the assessment approach, the color of dark or light blue in these figures represents low wind speed areas, green indicates moderate wind speeds, and yellow and red regions are associated with high wind speeds, as indicated on the color legend in the figures. The presence of red, and especially in specific areas for more than one wind direction, would indicate a high potential of the wind safety criterion being exceeded.

3.3 Characterization of Predicted Wind Conditions

Over the years, pedestrian wind conditions around buildings have been studied extensively through wind-tunnel testing[3]. These studies have created a broad knowledge base of wind conditions around different building forms. In many situations, the knowledge and experience, together with literature information, allow for a reliable estimation of pedestrian wind conditions without wind-tunnel testing[4]. RWDI has developed a program *(WindEstimator)* for qualitative screening-level pedestrian wind assessments. The program consists of a large data base of wind speed formulae as functions of building dimensions, orientations, spacing and surroundings. Predictions for general building forms are derived by combining predicted wind speeds with statistical models of local wind climate. This wind estimating tool served as a guide during the review of the computer wind flow simulations to estimate the relative potential of the wind safety criterion, described in Section 4, being exceed.

[3] ASCE Task Committee on Outdoor Human Comfort (2004). Outdoor Human Comfort and Its Assessment, 68 pages, American Society of Civil Engineers, Reston, Virginia, USA.

[4] T. Stathopolis, H. Wu and C. Bedard (1992). "Wind Environment around Buildings: A Knowledge-based Approach", Journal of Wind Engineering & Industrial Aerodynamics. 41-44, 2377-2388.

Based on our past experience in wind tunnel testing and knowledge of building and wind flow interactions, the wind conditions predicted for the Western Rail Yards were characterized, or compared to, what could be expected at other locations on Manhattan. To assist in identifying locations with wind conditions that may be comparable, aerial imagery was reviewed to determine locations that exhibit similar characteristics to the study area such as wind exposure, building massing/form and also the general surroundings.

4. RWDI WIND CRITERIA - WIND SAFETY

The wind conditions around the study site have been assessed by considering the wind safety criterion developed at RWDI. The criteria, developed by RWDI through research and consulting practice since 1974, have been published in numerous academic journals and conference proceedings. They have been widely accepted by municipal authorities as well as by the building design and city planning community. RWDI's criteria have in the past been extensively used by several major cities around the world to supplement their environmental planning guidelines.

The RWDI criteria deal with pedestrian safety, as it relates to the force of the wind. In this assessment, the focus is on the wind safety where gust wind speeds in excess of 55 mph can adversely affect a pedestrian's balance and footing. If winds of this magnitude occur more than three times per year the conditions would not meet the safety criterion and wind mitigation in most situations should be considered.

This assessment is qualitative in nature and thus the number of events that exceed the wind safety criterion cannot be quantified. However, experienced interpretation of the results of the computer simulations will guide the identification of the areas where severe winds can be expected, and the form of wind control measures needed. A comparison to the results of RWDI studies of other projects tested in the wind tunnel, including sites in Manhattan, also served as a guide in this assessment.

The table below presents a general classification of the severe wind events expected on the study site and surroundings based on the computer simulations and RWDI's experience in wind tunnel testing of developments for wind comfort and wind safety. This classification is used in the results section of this report.

Table 1 – Potential of Exceeding Wind Safety Criterion

Potential	Events	Mitigation
Low	< 3	None
Moderate	3-7	Localized wind control features and/or Building massing changes
High	> 7	Building massing changes

5. PEDESTRIAN WIND ASSESSMENT - RESULTS

5.1 General

In our discussion of anticipated wind conditions, reference will be made to the following generalized wind flows. Large buildings tend to intercept the stronger winds at higher elevations and redirect them down to the ground level. Such as *Downwashing Flow* (shown in Image 1) around tall buildings is often the main cause for wind acceleration at the pedestrian level. Also, when two buildings are situated side by side, wind flow tends to accelerate through the gap between the buildings due to the *Channeling Effect* (shown in Image 2). If these building/wind combinations occur for prevailing winds and especially for strong winds, there is an increased potential for the accelerated winds to create wind safety issues for pedestrians.

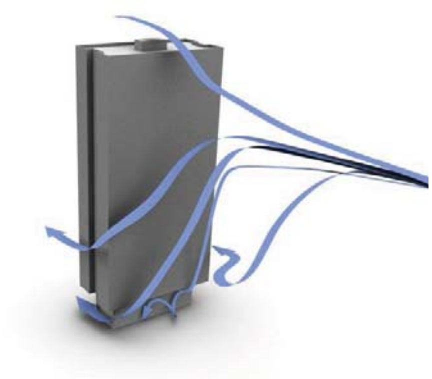


Image 1 - Downwashing Flows

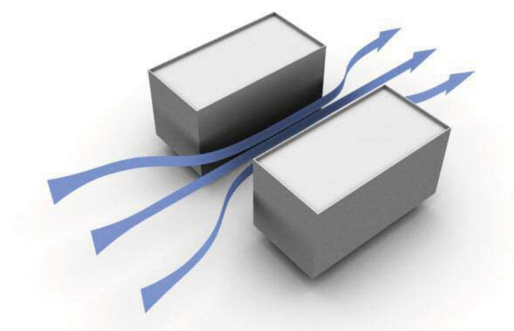


Image 2 - Channeling Flows

The following describes the anticipated pedestrian wind conditions at notable pedestrian areas on and around the proposed Western Rail Yard development. As described in Section 3 (Approach), these estimates are based on the results of *WindEstimator* and *Virtualwind*^{TM} simulations and our experience in testing, interpreting and understanding building aerodynamics.

Wind conditions on and around the Western Rail Yard site will be influenced by the many surrounding buildings, including the proposed Western Rail Yard development, the Eastern Rail Yard development and other nearby future developments. To reduce wind gusts at pedestrian-level around the Western Rail Yard site, potential solution concepts (including suggestions for massing changes and added wind control features) have been noted, where appropriate, for future consideration by the design team. However, as the wind patterns and resultant conditions are caused by the interaction of wind flow around multiple buildings, it is important to understand that mitigation may not be possible by changing or adding features to just one building.

One of the dominant issues controlling wind conditions at this site is the open exposure to strong winds from the northwest quadrant. There are no existing buildings to the west to shelter the development site. In our opinion, it would require significant building height reductions across the site, on the order of 50%, to appreciably change the expected conditions. A 10% or 20% reduction in building heights will unlikely cause a significant reduction in ground-level wind activity. Hence, building height reductions were not considered a practical mitigation concept for the current development site.

5.2 Predicted Wind Conditions - Existing Configuration

There are a number of existing low-rise buildings on the Western Rail Yard site (Figure 2a). While the site is exposed to the prevailing westerly and northwesterly winds, minimal ground-level wind acceleration occurs as the existing buildings do not significantly influence the wind patterns on the site (Figure 6). This results in a low potential for the wind safety criterion being exceeded on the existing Western Rail Yard site.

To characterize the wind conditions at the existing Western Rail Yard site, we anticipate that conditions would be similar to other open areas east of the Hudson River, such as Riverbank State Park (vicinity of Riverside Drive and West 138th to 145th Streets). This park has a comparable open exposure to wind approaching across the Hudson from the west through northwest directions. The sports field located beyond the west end of West Houston Street appears to be another site that exhibits similar site characteristics to the existing Western Rail Yard site. This location and Riverbank State Park both project into the Hudson River beyond the shoreline, which increases their wind exposure, but would generally serve as relatively comparable sites. We anticipate that these locations would be rated with a low potential to exceed the wind safety criterion.

Finally, in the Robert F Wagner Jr. Park near the Statue of Liberty Ferry Terminal, the water's edge of the promenade facing Liberty Island is a good example of a location at the south end of Manhattan that is highly exposed to the west and northwest winds. However, this location is also completely exposed to southerly winds, thus the wind conditions experienced at this location would be more severe than those experienced at the existing Western Rail Yard site, especially in the summer. Because of the increased exposure to many wind directions, the potential for winds to exceed the wind safety criterion would be low to moderate.

5.3 Predicted Wind Conditions - No-Build Configuration

The addition of the high-rise towers east of 11th Avenue as well as other future buildings (Figure 2b) will have a minimal effect on the wind conditions on the Western Rail Yard site (Figures 7a and 7b). These future buildings are mainly downwind of the study site for the prevailing westerly through northwesterly directions. Overall, a low potential for winds to exceed the wind safety criterion is predicted on the Western Rail Yard site for the No-Build Configuration. The wind conditions on the Western Rail Yard site for the No-Build Configuration can generally be characterized by the same locations described for the Existing Configuration.

5.4 Predicted Wind Conditions - Full-Build Configuration

The Western Rail Yard development includes building massing comprised of eight mid to high-rise towers. The prevailing westerly through northwesterly winds will be intercepted at higher levels by the exposed portions of the towers and channeled and/or re-directed towards grade-level, resulting in wind acceleration in several areas on site (see Figures 8a, 8b and 8c). Based on our assessment that considered all wind directions, several areas across the site have been identified as having the potential to exceed the criterion. The slenderness and open spacing of the towers on the western portion of the site are generally positive design concepts with respect to wind effects at grade. Figure 9 shows a site plan with shading that represents areas where there is a potential to exceed the criterion due to increased wind activity. The identified areas are discussed in the following section for each building on the Western Rail Yard site. A general description of the wind patterns around each building and recommendations of concepts for mitigation and wind control have been provided for each building mass.

To help characterize the range of wind conditions expected at the Western Rail Yards Full-Build Configuration, 3D aerial images of Manhattan were reviewed in conjunction with the wind roses and application of our experience and knowledge in building aerodynamics. Given the orientation, massing and spacing of buildings along the west side of Manhattan, in, for example, the general vicinity of the World Financial Center, the potential exists for the downwashing wind flow (Image 1) and the channeling wind flow (Image 2) to occur for buildings with long facades oriented north/south. Where these wind flows can readily occur for west through northwest winds, experience suggests that a high potential to exceed the wind safety criterion could develop. A review of 3D aerial imagery also helped identify another area where similar increased wind activity may be expected. Buildings along the east side of Riverside Boulevard, between West 63rd and West 72nd Streets, for example are well exposed to the northwest quadrant winds. The site exposure and general massing of buildings in this area are attributes associated with a high potential to exceed the wind safety criterion.

Overall, the results of the wind flow simulations for the Western Rail Yard exhibit comparable wind conditions found in other sites along West Manhattan, and include a similar range of wind safety events due to the same exposure to the prevailing northwest winds.

WR-7 and WR-6

Towers WR-7 and WR-6, located at the corner of 12th Avenue and West 33rd Street, are exposed to the prevailing westerly through northwesterly winds. These winds will be intercepted by the towers and downwashed toward grade, accelerating around the northwest corner of WR-7 and the northeast corner of WR-6 (Figures 8a, 8b and 8c). Westerly through northwesterly winds are also expected to downwash off WR-6, then channel between WR-6 and WC-1. A moderate potential for the wind safety criterion being exceeded is expected for these areas (Locations A, B and C in Figure 9).

There are several options that can be considered to reduce wind acceleration in Area A. These include shifting the WR-7 Tower further eastward, to create a podium on the west side of the building. This podium will help to re-direct the strong wind flows before they reach grade. Alternatively, the design team may consider a chamfer (see Image 3) or notch feature on the tower's northwest corner. This feature could extend from grade or from the podium level and should extend a minimum of five storeys in height. The chamfered building corner will help dissipate wind flows as they travel down the building facade towards grade. The addition of a canopy or colonnade may also be considered along the west and north facade of the tower, to provide a sheltered area for pedestrians on windy days.

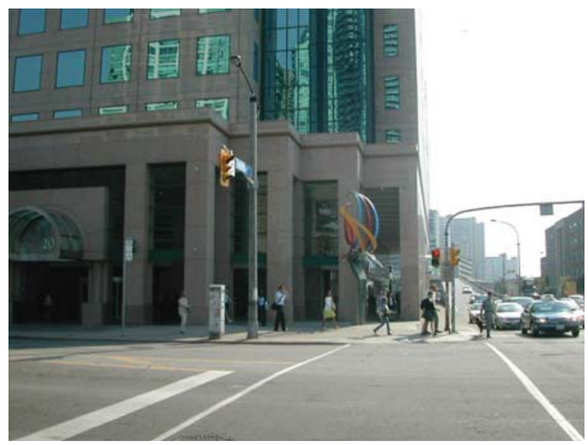


Image 3 – Corner chamfer

Potential solution options that may be considered for Area B include increasing the height of the central section of the podium between WR-6 and WR-7, by several storeys. The design team may also consider "terracing" the north and south sides of the podium (see Image 4). The "terracing" should range from the present podium height at the north and south edges to about 6 to 8 storeys above the podium. This measure will act to disrupt the channeling and downwashing of westerly winds. Another measure that would have a similar effect would be to modify the WR-6 Tower into an "L" shape, by extending several bays of the west façade near West 33rd Street along to the west. With an increased podium height and/or an "L" shaped tower floor plate, wind flows will continue to downwash from the WR-6 Tower, but will be disrupted atop the podium and dissipate before reaching grade-level.

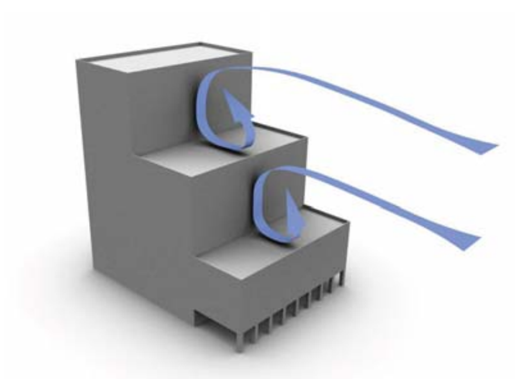


Image 4 – Terracing with Colonnade

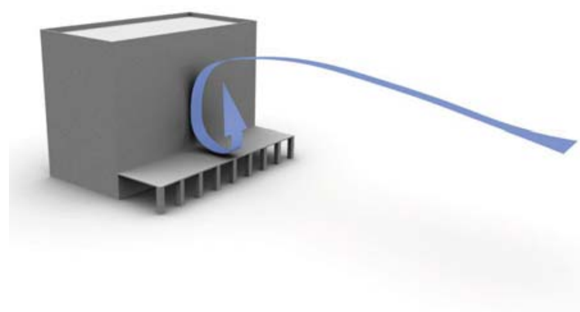


Image 5 – Canopy/Colonnade

Similar measures may be investigated for Area C. The addition of a podium at the south end of the WR-6 Tower will reduce gusts at grade. This could be accomplished with the "L" shape design concept described in the preceding paragraph. Another option would be to include a chamfer or notch feature on the southeast corner of the tower, from the podium by approximately five storeys. Alternatively, a canopy or colonnade (see Image 5) wrapping around the south and east facade of the WR-6 Tower may also be considered to deflect wind flows from grade and provide a sheltered alternative route for pedestrians on windy days.

WR-5

WR-5, located to the south of WR-6, is oriented such that the west facade is approximately perpendicular to the prevailing westerly winds. This results in a significant downwashing flow, which then accelerates around the west corner of the tower at grade. The proximity of this tower relative to WR-6 plus its exposure, creates a channeling effect. A high potential for the wind safety criterion being exceeded is therefore expected in this area (Area D in Figure 9).

Potential design solution concepts to be considered include the addition of a podium wrapping around the west facade of WR-5, which will help to deflect downwashing winds away from grade, and increasing the distance between the WR-5 and WR-6 Towers (e.g., shifting the WR-6 Tower northward on the podium in the "L" shape discussed previously) would help reduce the channeling effect.

WR-4

The orientation and shape of the WR-4 Tower is a positive aerodynamic design, as the small windward face on this wind exposed tower, minimizes the downwashing effect. A channeling effect is expected to occur between the WR-4 and WR-5 Towers for the northwest winds, resulting in a high potential for the wind safety criterion being exceeded at Area E (Figure 9). Northwesterly winds will also accelerate around WR-4 causing increased wind activity to the southwest corner of the WR-4 Tower. A moderate potential for the wind safety criterion not being met is predicted for this area (Area F in Figure 9).

To reduce the channeling effect between WR-4 and WR-5, the distance between the towers would need to be increased. However, it is expected that re-locating WR-5 would increase the potential for wind acceleration in other areas of the site. Instead, the design team may consider a horizontal feature (e.g., trellis, podium) connecting WR-4 and WR-5, to keep higher wind speeds above the plaza. Another option to reduce the channeling effect would be to consider hard and/or soft landscape features (e.g., windscreens, trees that retain their leaves in the winter, etc.) throughout this area. An example of glazed windscreens is shown in Image 6.

Image 6 – Glass Windscreens

Reducing the wind acceleration around the southwest corner of WR-4 is challenging to accomplish using building massing changes given the complexity of the site in this area. The tower is well shaped for the wind and a massing change, such as a podium would not be overly effective. Instead, a combination of hard and soft landscaping may be considered in the future, and can include features such as windscreens, coniferous landscaping (Image 7), etc. to help shelter pedestrians using the sidewalks south of the tower.

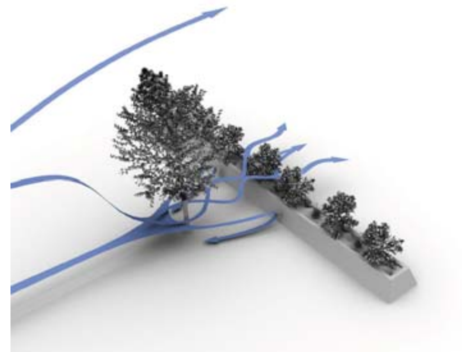


Image 7 – Landscape Buffer

WR-2 and WR-3

The prevailing westerly through northwesterly winds will be intercepted by WR-3 and will tend to downwash towards grade. This is expected to result in a moderate potential for exceeding the wind safety criterion (Area G in Figure 9). Additionally, westerly winds will downwash from the proposed building across 11th Avenue (ER-2) and channel between WR-2 and ER-2, resulting in a low to moderate potential for exceeding the wind safety criterion in Area H.

Shifting the WR-3 Tower toward the east to create a podium on the west side of the tower will reduce the downwashing effect by deflecting winds away from grade. A large canopy, a colonnade or extending the podium along the west facade may also be considered as possible concepts. Another alternative to be considered would be to create a slot or 2nd to 4th floor undercut on the west facade, which will help to interrupt and disperse the downwashing flow.

To reduce the potential for wind safety failures in Area H, massing changes for ER-2 will also be necessary and may, include the addition of a podium. Additionally, creating a colonnade feature along the east facade of WR-2, or landscape elements (e.g., a wind screen with protective canopy shown in Image 8) between the sidewalk and the street will provide a sheltered area for pedestrians on windy days. The design team may also consider chamfering the southeast corner of the WR-2 podium.

Image 8 – Glass windscreen and canopy

WR-1

Prevailing westerly through northwesterly winds will be intercepted by the WR-1 Tower and will downwash toward grade, resulting in a moderate potential for the wind safety criterion to the west of the tower being exceeded (Area I in Figure 9). Shifting the tower towards the east on the podium will increase the podium area to the west of the tower, or rotating the tower approximately 60° clockwise would help keep gusting winds above grade

WC-1

Wind activity in this area is strongly influenced by several buildings, including WC-1, ER-3/EH-1, and the future development on the east side of 11th Avenue to the north of the Eastern Rail Yard. ER-3/EH-1 and the future developments create a large blockage (represented conceptually as one block in Image 9), having a significant effect on the overall wind flows in the area. Winds are intercepted by the future developments and ER-3/EH-1, and then downwash toward grade. This effect is amplified by the addition of WC-1, which causes the re-directed flow to channel along 11th Avenue, adding to the downwashing effect. The result is a large area along 11th Avenue and on the Eastern Rail Yard site having a high potential for the wind safety criterion being exceeded (Area J in Figure 9).

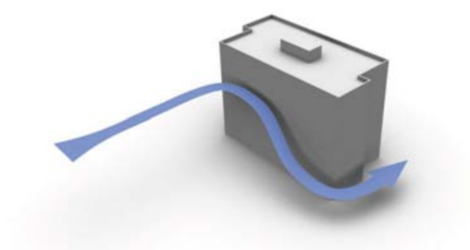


Image 9 – Angled Flow

Mitigation of the high wind speeds in the area will be challenging without modification of the off-site buildings. However, the following options can be considered for reducing severe wind events locally on the Western Rail Yard site. Extending the podium along the east side of the WC-1 Tower to the north adding a podium along the north face and/or shifting the tower to the south will help to deflect some of the downwashing wind flows away from grade. Additional design measures are also suggested and may include for example, a colonnade, windbreaks, etc., along the east facade of WC-1. At present, the 3D model indicates the location of an entrance plaza at the notched northeast corner of WC-1. Due to the potential of high wind gusts in this area, it is expected that hard and/or soft landscape elements in addition to the massing changes, must be considered during the schematic design of this building. An alternative location for the plaza would be near the southeast corner of the tower.

6. MITIGATION

The following conceptual measures are recommended for consideration by the design team to reduce wind activity in and around the Western Rail Yard development. The various concepts identified are intended to serve as a design guide during future refinement of building masses to improve upon the buildings' aerodynamic performance. Thus in reviewing the listed concepts presented for each building, it is important to understand that one or more of the concepts may apply, as described in the detailed discussions (Section 5). However, during the future schematic design of the proposed massings, the decision of which concept(s) to apply will also be influenced by other factors (e.g., views, aesthetics, marketability, etc.). Refer to Figure 9 for the location of the lettered reference areas.

WR-7 and WR-6

- Create a podium on the west side of the building by shifting WR-7 toward the east (Area A).
- Add a chamfer to the northwest tower corner, extending from grade or from the podium level, a minimum of 3 storeys in height (Area A).
- Add a colonnade along the west and north facade of WR-7 (Area A)
- Increase the height of the center of the podium (Area B).
- Re-design the WR-6 Tower into an "L" shape (Area B).
- Add a chamfer or notch feature on the southeast corner of the WR-6 Tower (Area C).
- Add a canopy or colonnade wrapping around the south and east facade of the WR-6 Tower (Area C).

WR-5

- Add a podium wrapping around the west facade of WR-5 (Area D).
- Increase the distance between WR-5 and WR-6 by shifting the WR-6 Tower northward on the podium (Area D).

WR-4

- Create a podium connecting WR-4 and WR-5 (Area E).
- Install a series of tall wind screens between WR-4 and WR-5 (Area E).
- Utilize a combination of hard and soft landscaping including wind screens and coniferous landscaping for Area F.

WR-2 and WR-3

- Shift the WR-3 Tower toward the east to create a podium on the west side of the tower (Area G).
- Add a canopy, colonnade or undercut along the west facade of the WR-3 Tower (Area G).
- Add a colonnade along the east facade of the WR-2 Tower or add a wind screen with overhead canopy between the sidewalk and the street along the east side of WR-2 (Area H).

WR-1

- Shift the tower toward the east on the podium to increase the podium area to the west of the tower (Area I).
- Rotate the tower approximately 60° clockwise.

WC-1

- Extend the podium along the east side of the WC-1 Tower to the north
- Shift the tower to the south (Area J).
- Add a podium along the north face (Area J).
- Add a colonnade, wind breaks, etc., along the east facade of WC-1 (Area J).

FIGURES

Orientation Plan
Full-Build Configuration

Western Rail Yard - New York, New York

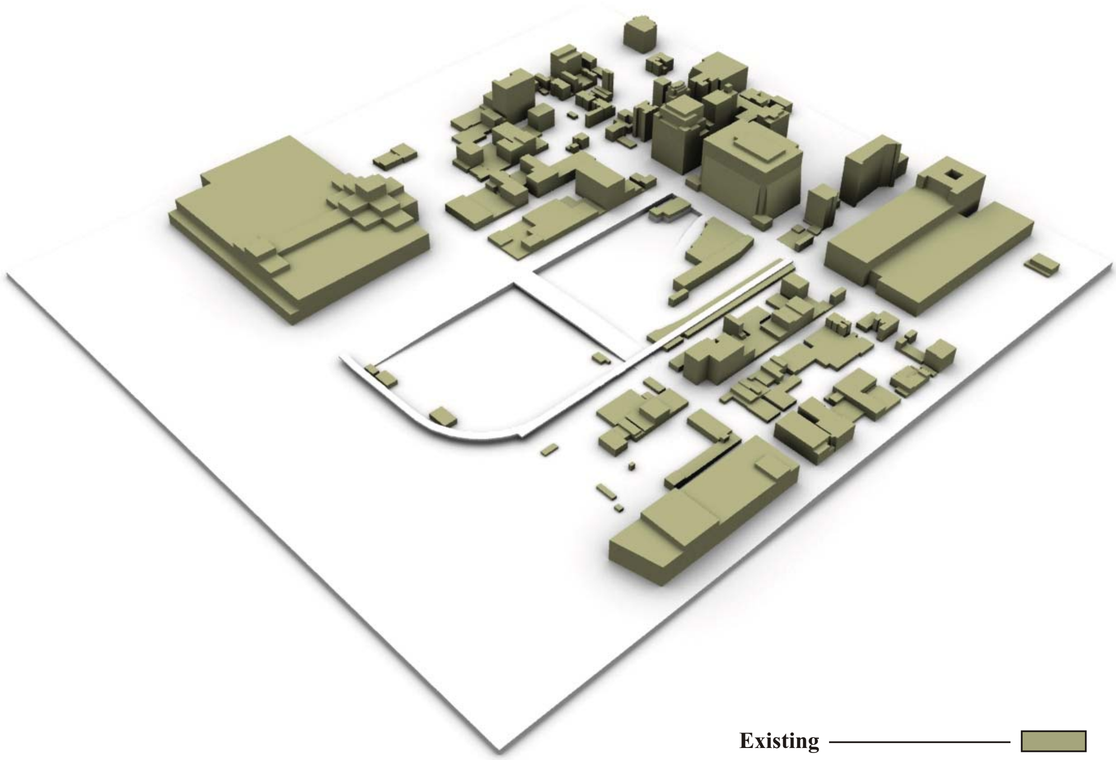
Reference North True North

Project #0940081

Drawn by: ACM	Figure: 1
Approx. Scale: 1"=250'	
Date Revised: May 11, 2009	

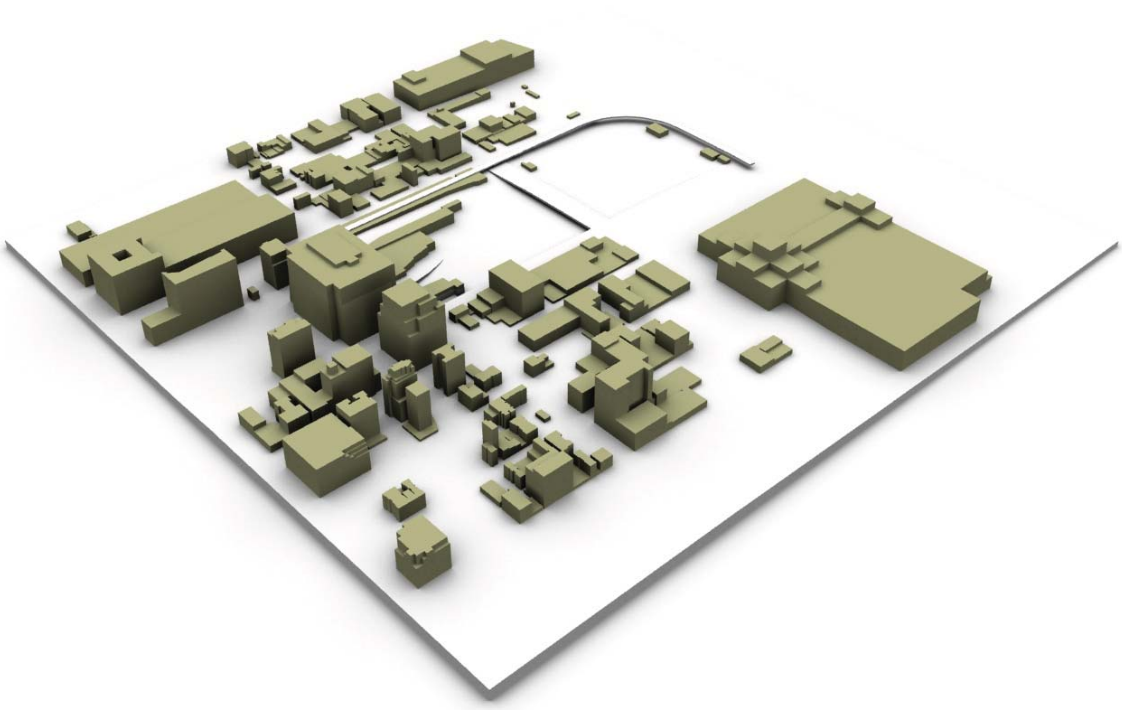
RWDI

View from the West



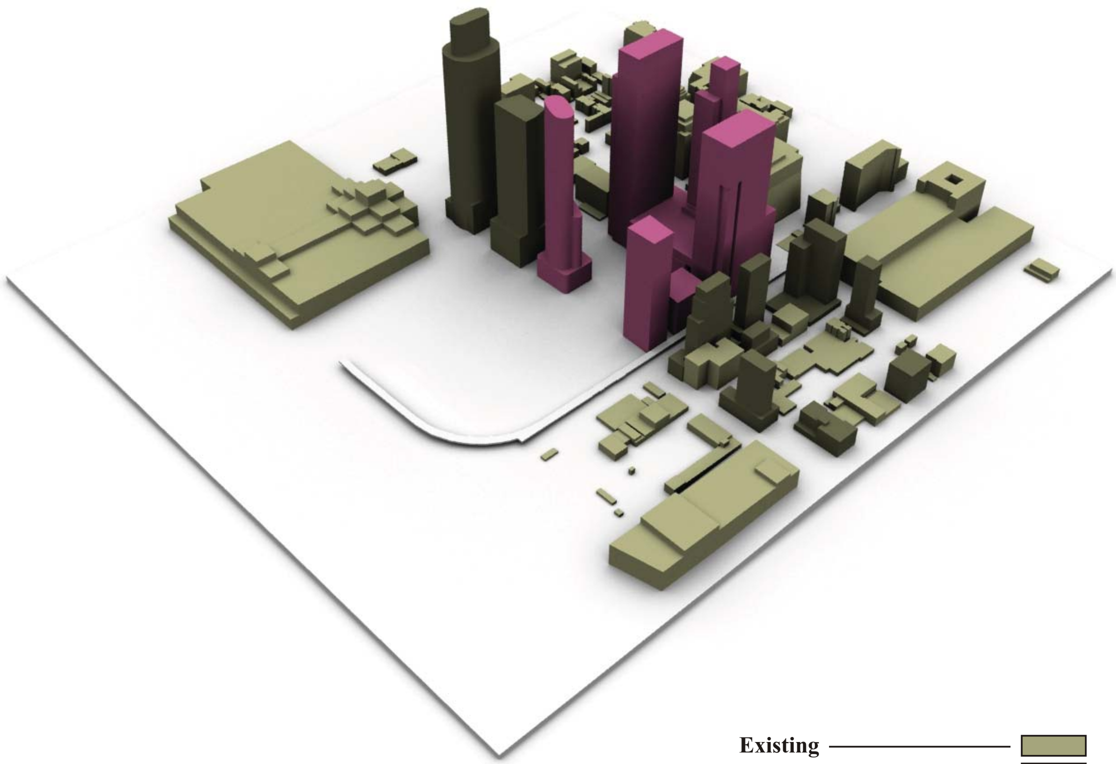
Existing

View from the East

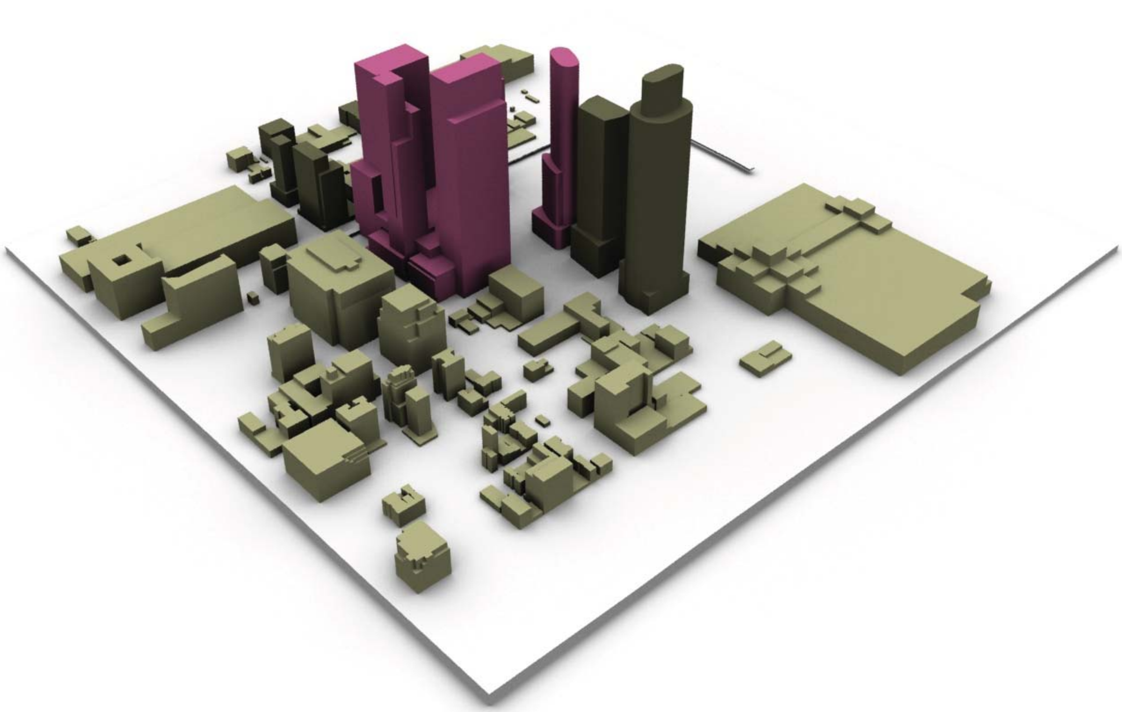


Wind Simulation Model **Existing Configuration**	Figure: 2a	RWDI
	Produced by: ACM	
Western Rail Yard - New York, New York Project #0940081	Date Revised: April 17, 2009	

View from the West

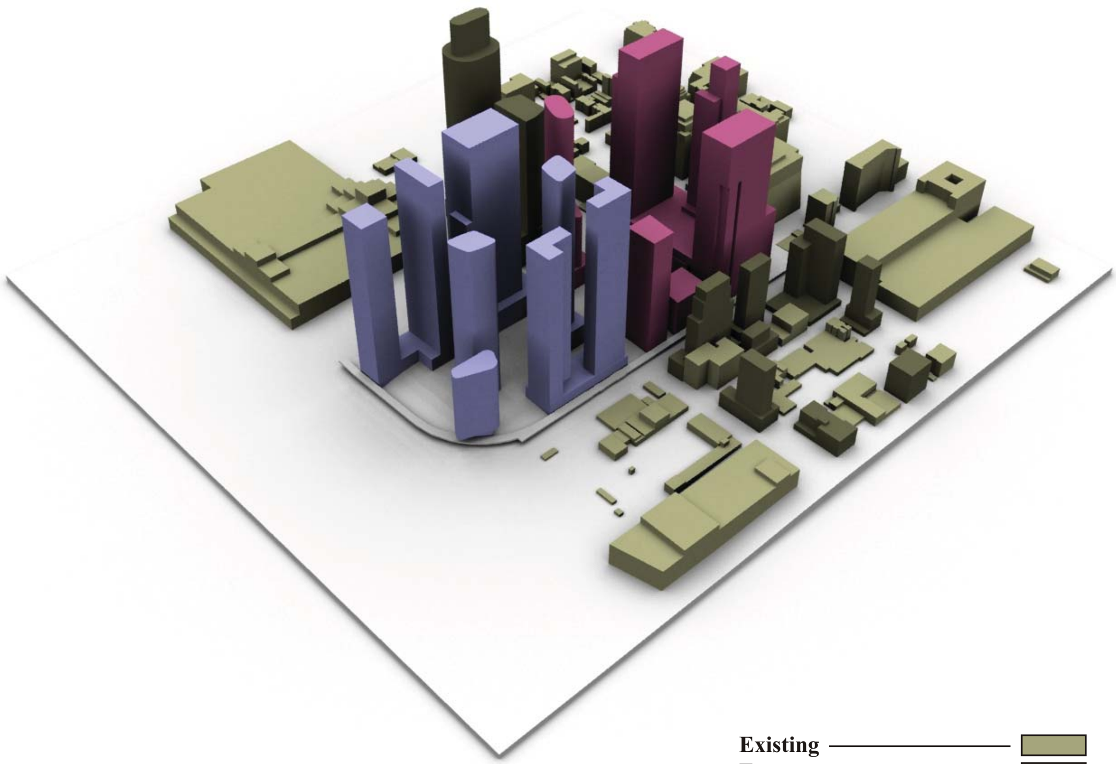


View from the East



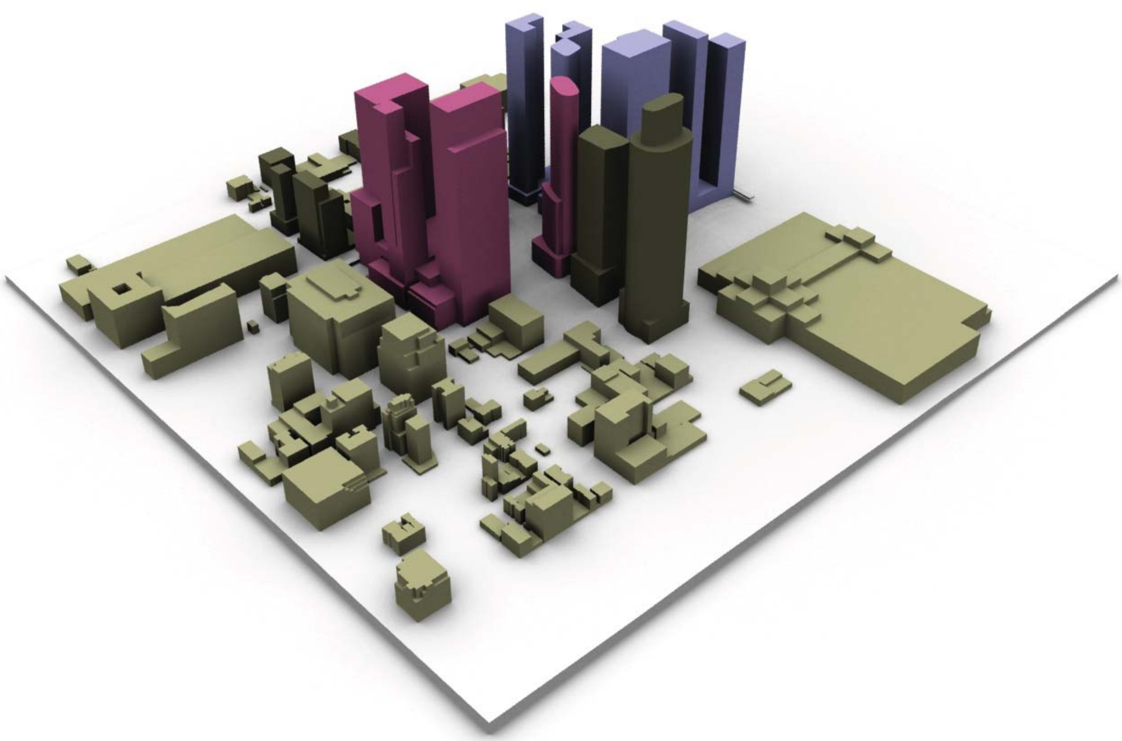
Wind Simulation Model No-Build Configuration Western Rail Yard - New York, New York	Project #0940081	Figure: 2b Produced by: ACM Date Revised: April 17, 2009	RWDI

View from the West

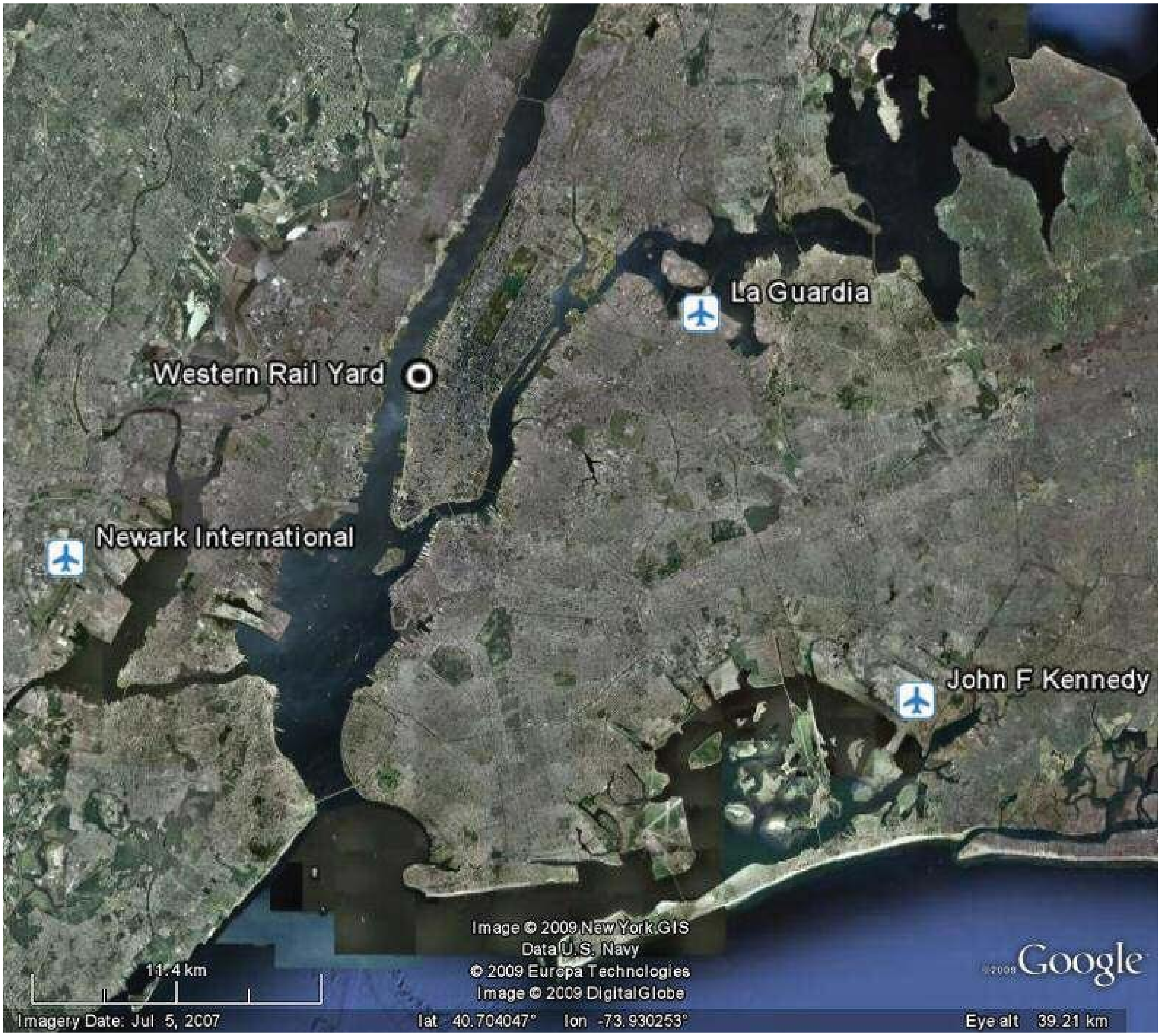


Existing
Future
Eastern Rail Yard
Western Rail Yard

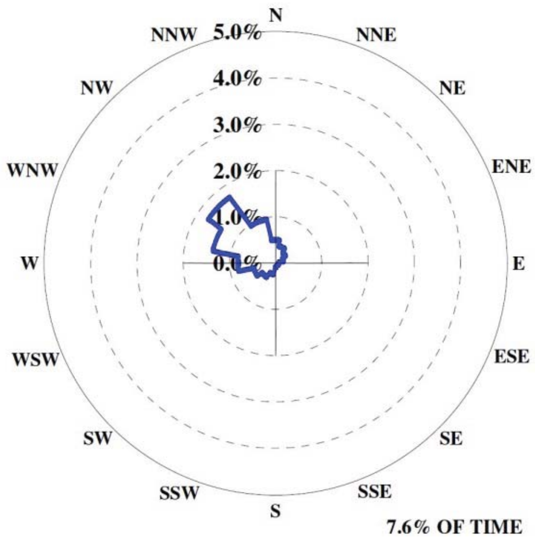
View from the East



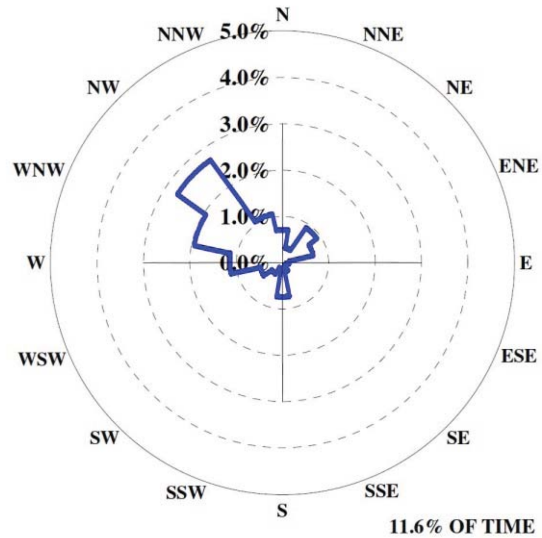
Wind Simulation Model **Full-Build Configuration**	Figure: 2c	RWDI
	Produced by: ACM	
Western Rail Yard - New York, New York Project #0940081	Date Revised: April 17, 2009	



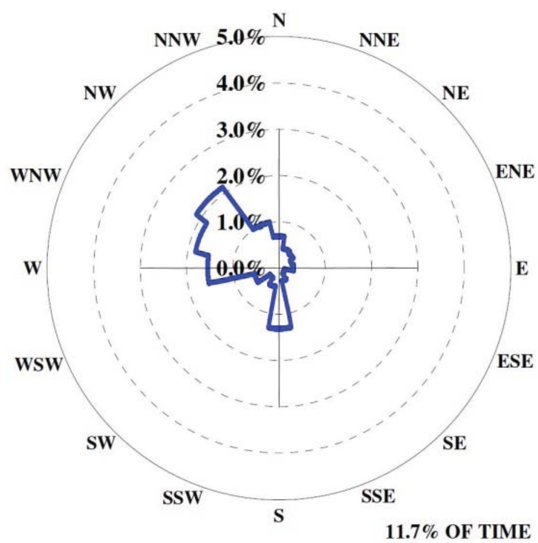
Location of Study Site and Airport Wind Data Sites **(Image Courtesy of Google™ Earth)**	True North	Figure: 3	RWDI
Western Rail Yard - New York, New York	Project #0940081	Date: May 7, 2009	



Newark Airport



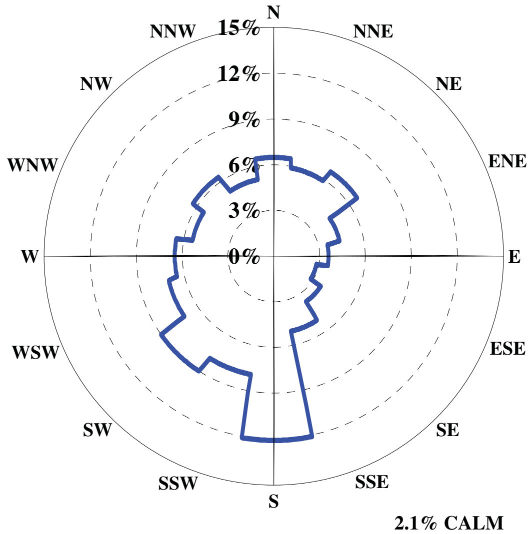
La Guardia Airport



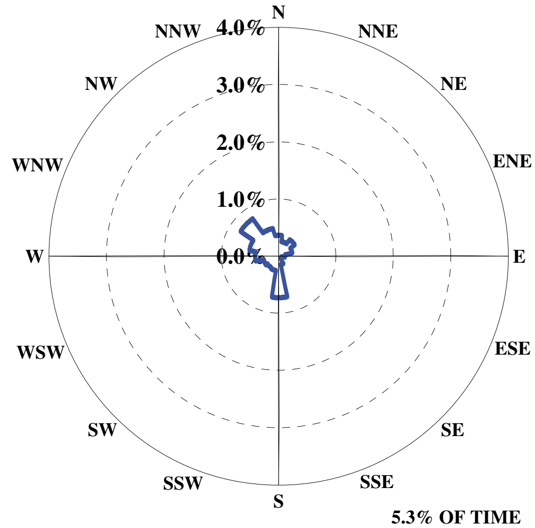
JFK Airport

ANNUAL WINDS EXCEEDING 20 mph

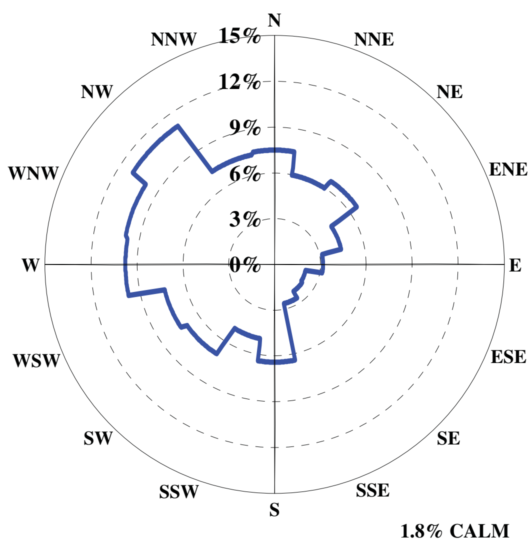
Directional Distribution (%) of Winds (Blowing From) **Station: Newark, LaGuardia and JFK Airports (1948 - 2005)**	Figure: **4**	RWDI
Western Rail Yard - New York, New York Project #: 0940081	Date: May 7, 2009	



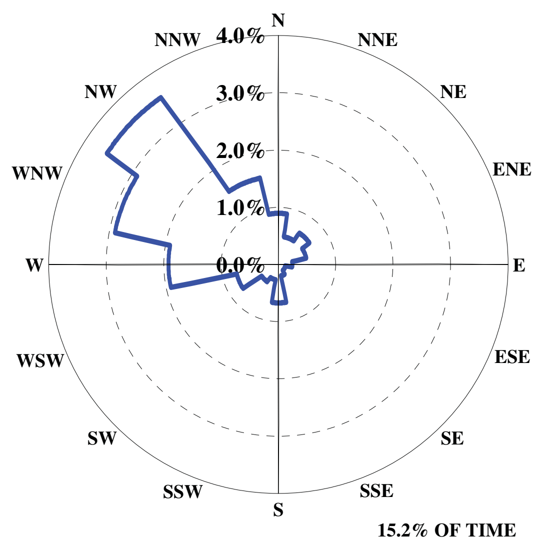
ALL SUMMER WINDS



SUMMER WINDS EXCEEDING 20 mph



ALL WINTER WINDS



WINTER WINDS EXCEEDING 20 mph

Directional Distribution (%) of Winds (Blowing From)

Station: **New York City Combined (JFK, Laguardia and Newark), NY (1948 - 2005)**

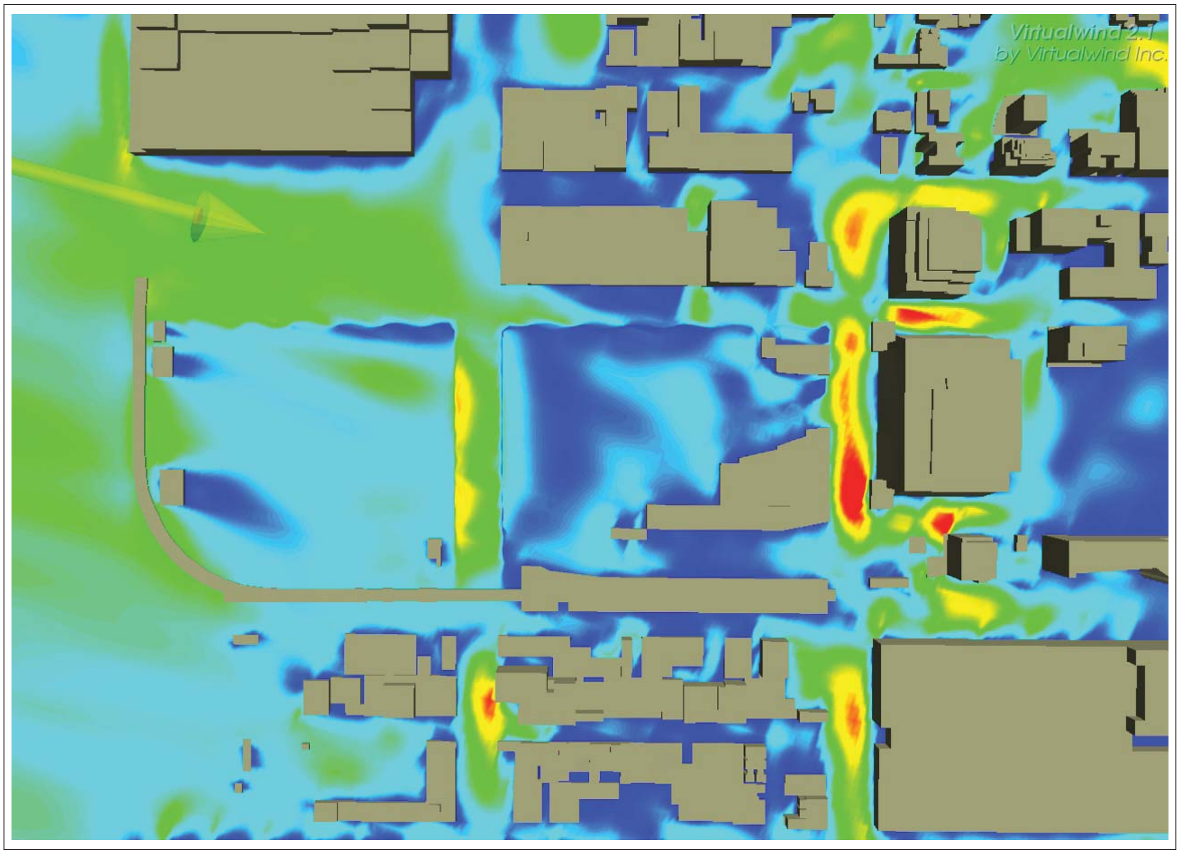
Western Rail Yard - New York, New York

Project #: 0940081

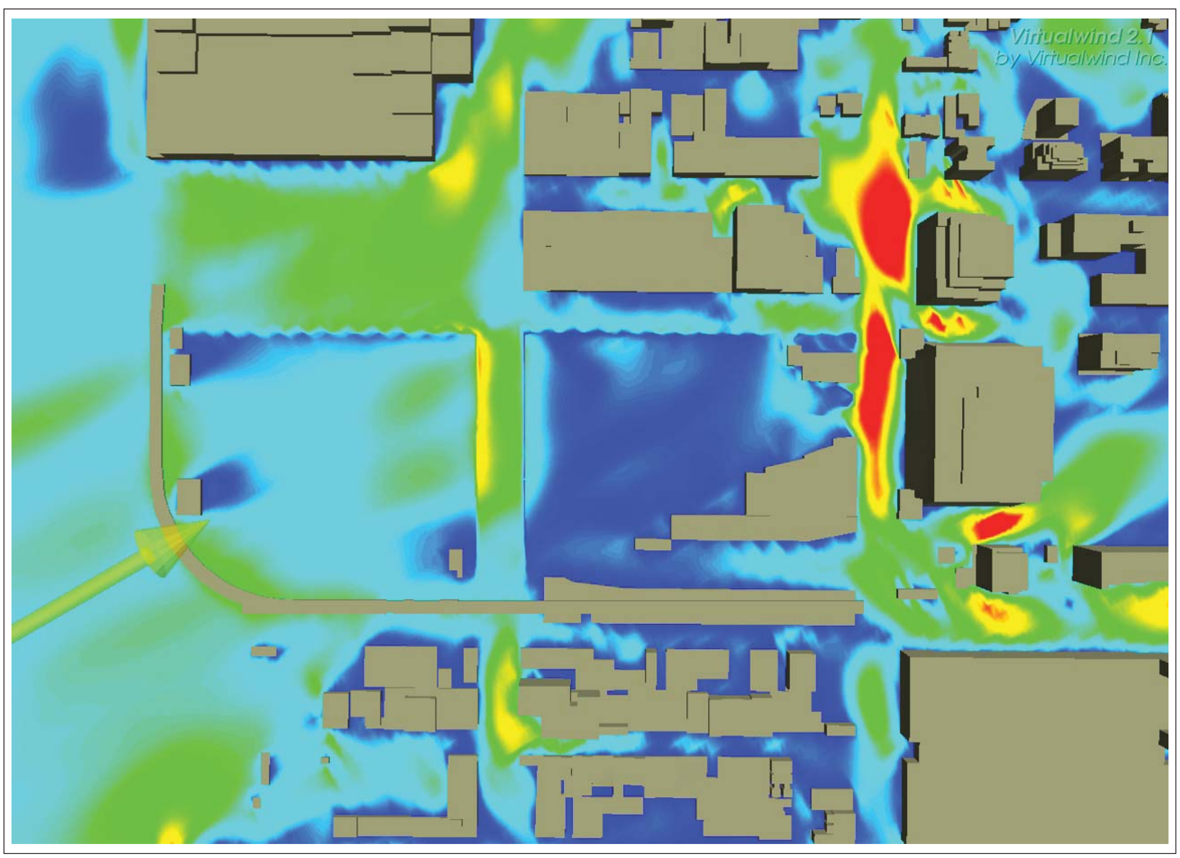
Figure: **5**

Date: May 7, 2009

RWDI



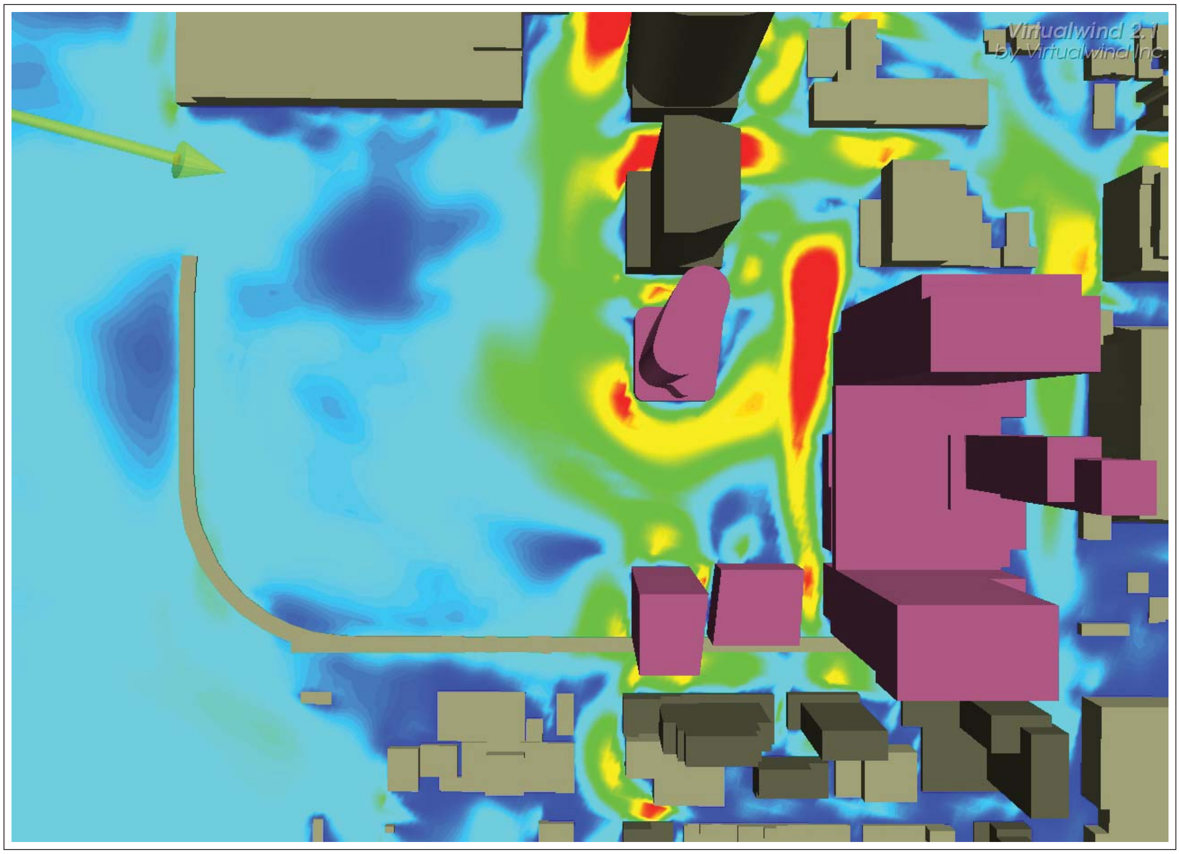
Winds from the Northwest



Winds from the West

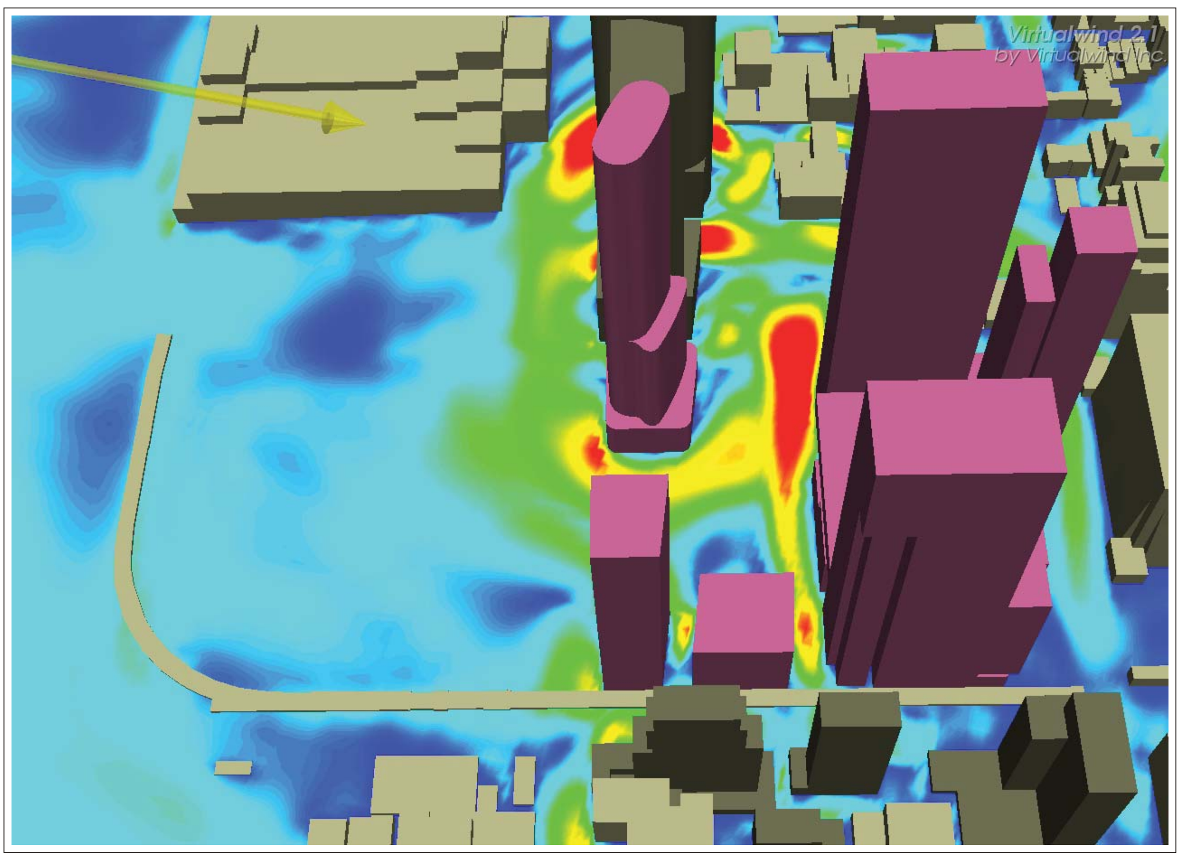
Wind Simulation Results: Existing Configuration	Figure:	6
	Produced by:	ACM
Western Rail Yard - New York, New York — Project #0940081	Date Revised:	May 7, 2009

RWDI



Low High

Wind Speed



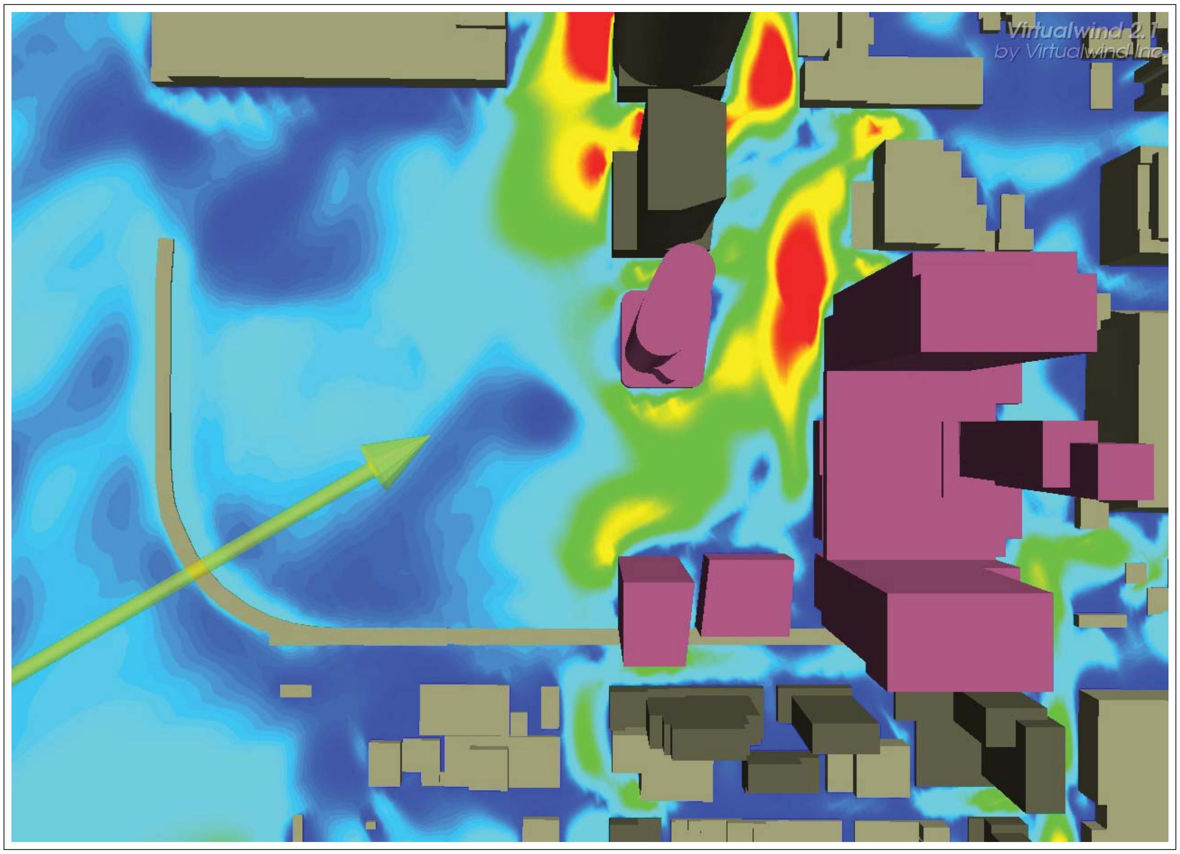
Wind Simulation Results: No-Build Configuration
Winds from the Northwest

Western Rail Yard - New York, New York

Project #0940081

Figure:	7a
Produced by:	ACM
Date Revised:	May 7, 2009

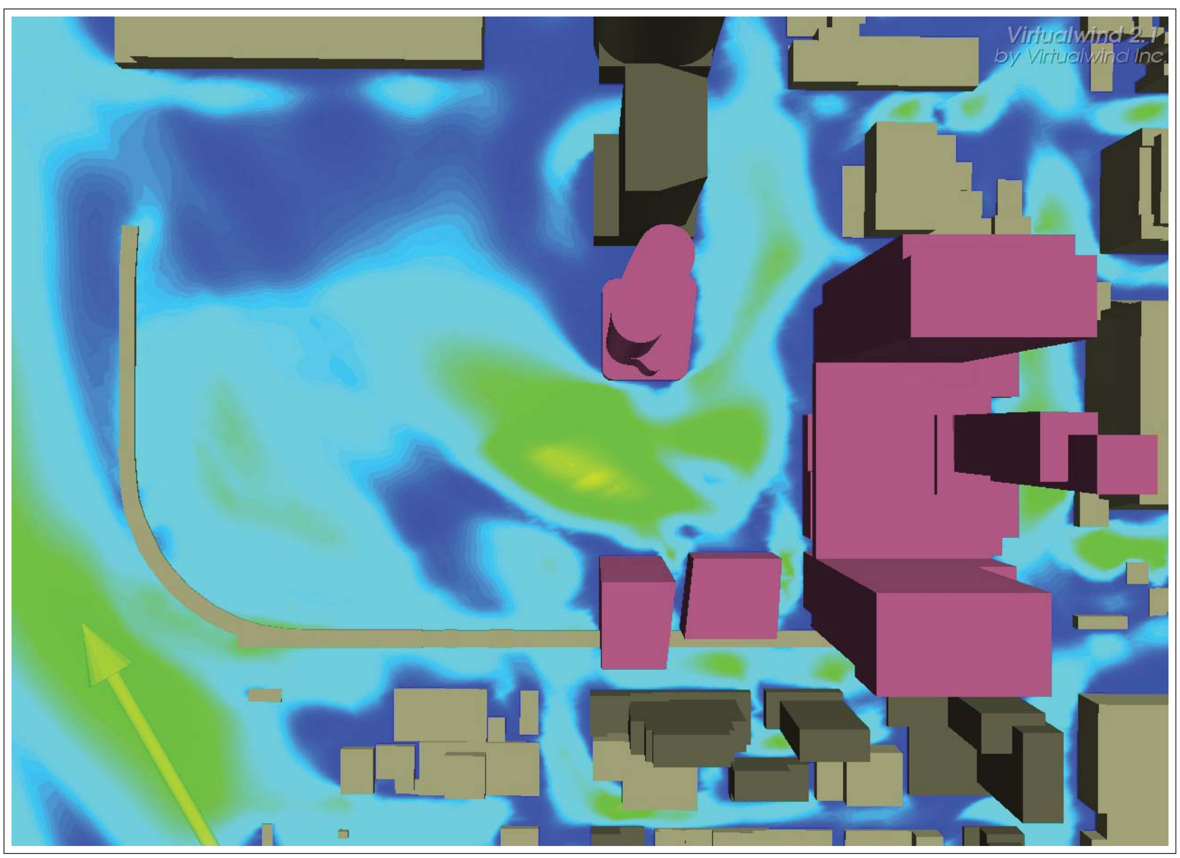
RWDI



Winds from the West

Low High

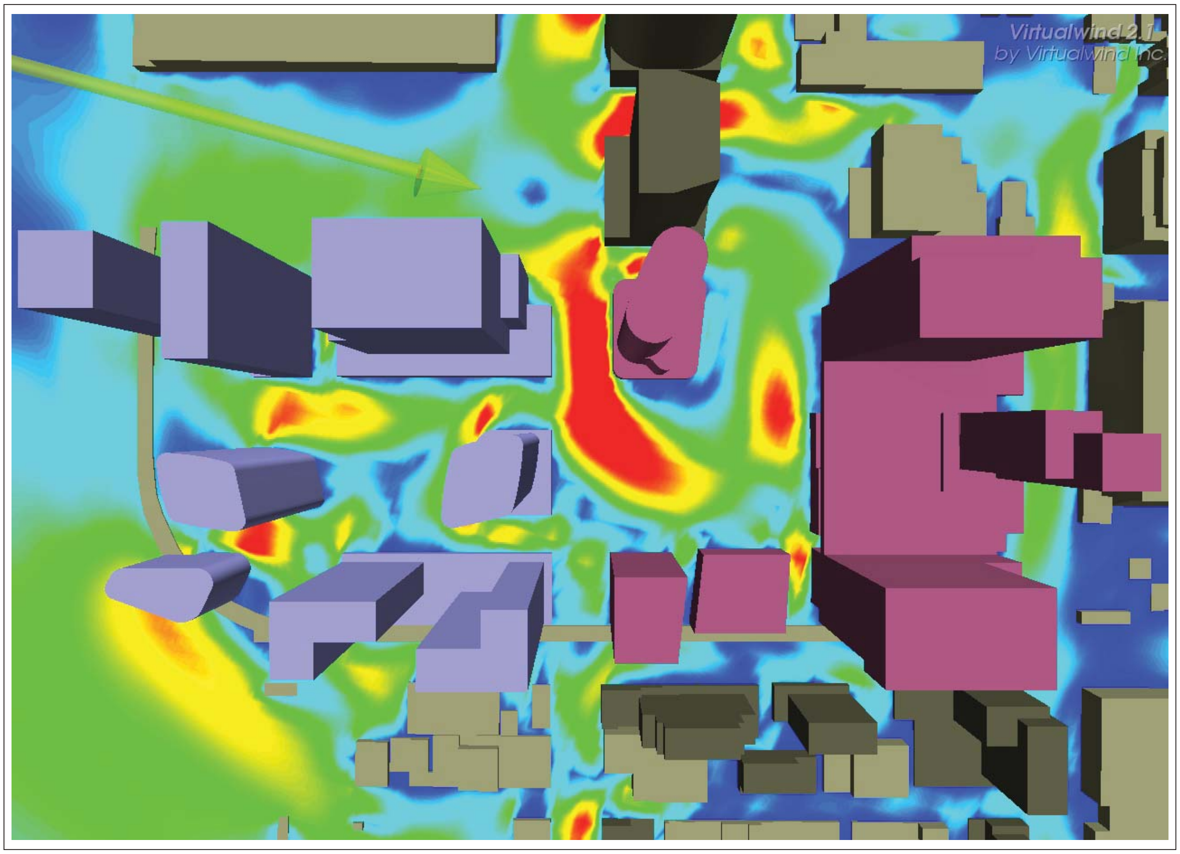
Wind Speed

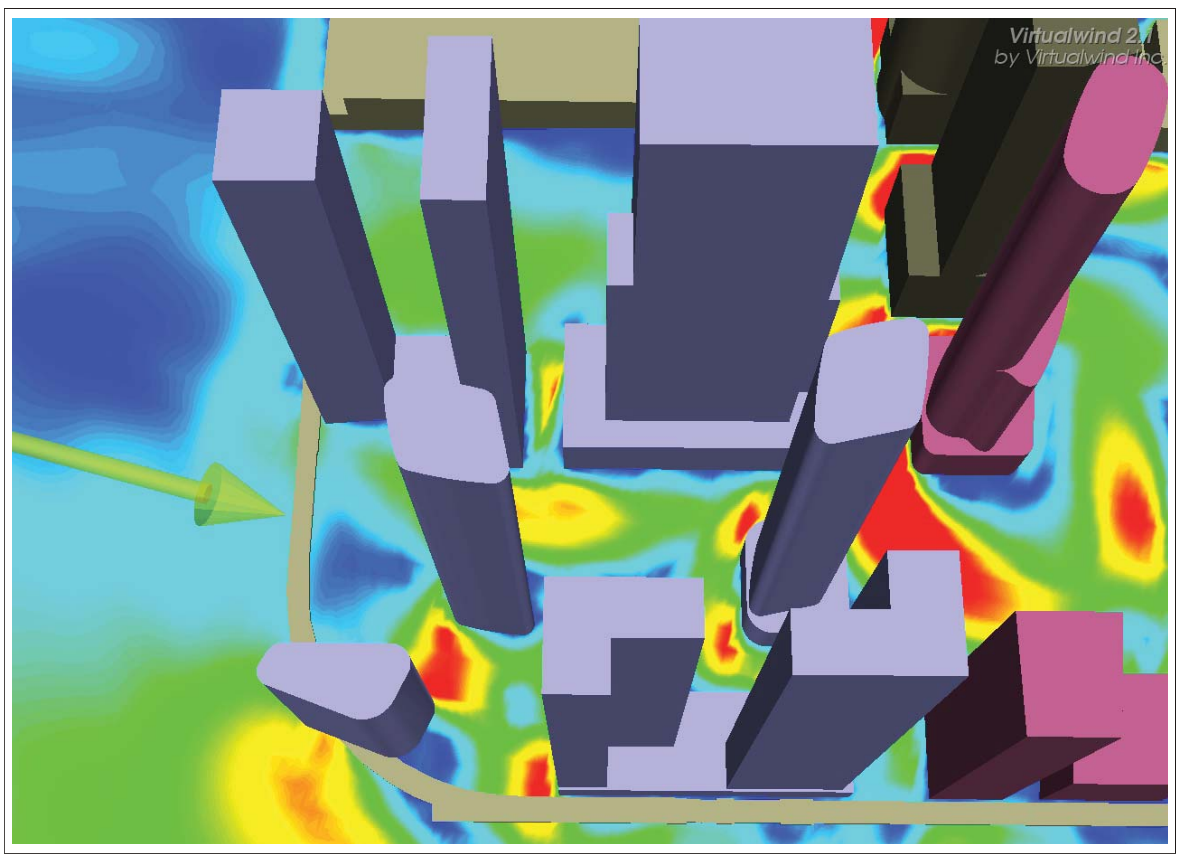


Winds from the South

Wind Simulation Results: No-Build Configuration	Figure:	7b
	Produced by:	ACM
Western Rail Yard - New York, New York Project #0940081	Date Revised:	May 7, 2009

RWDI





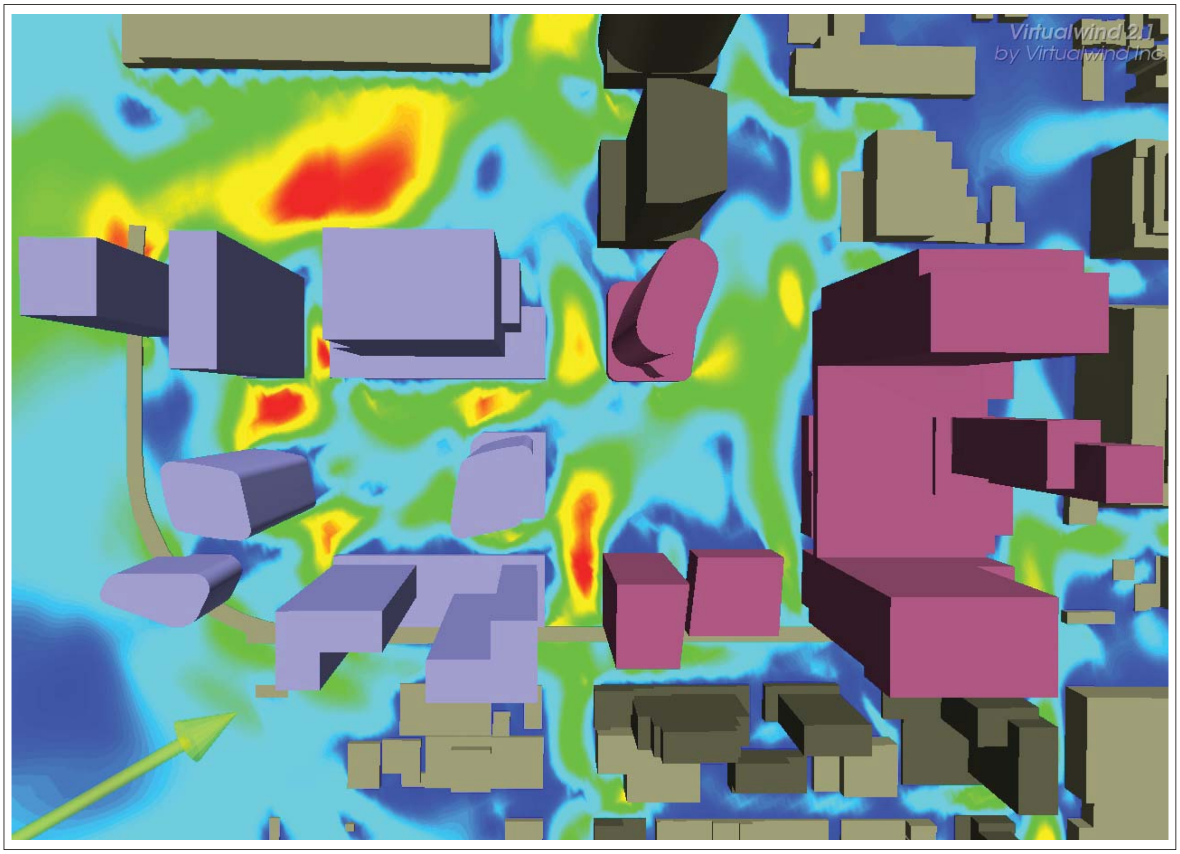
Wind Simulation Results: Full-Build Configuration
Winds from the Northwest

Western Rail Yard - New York, New York

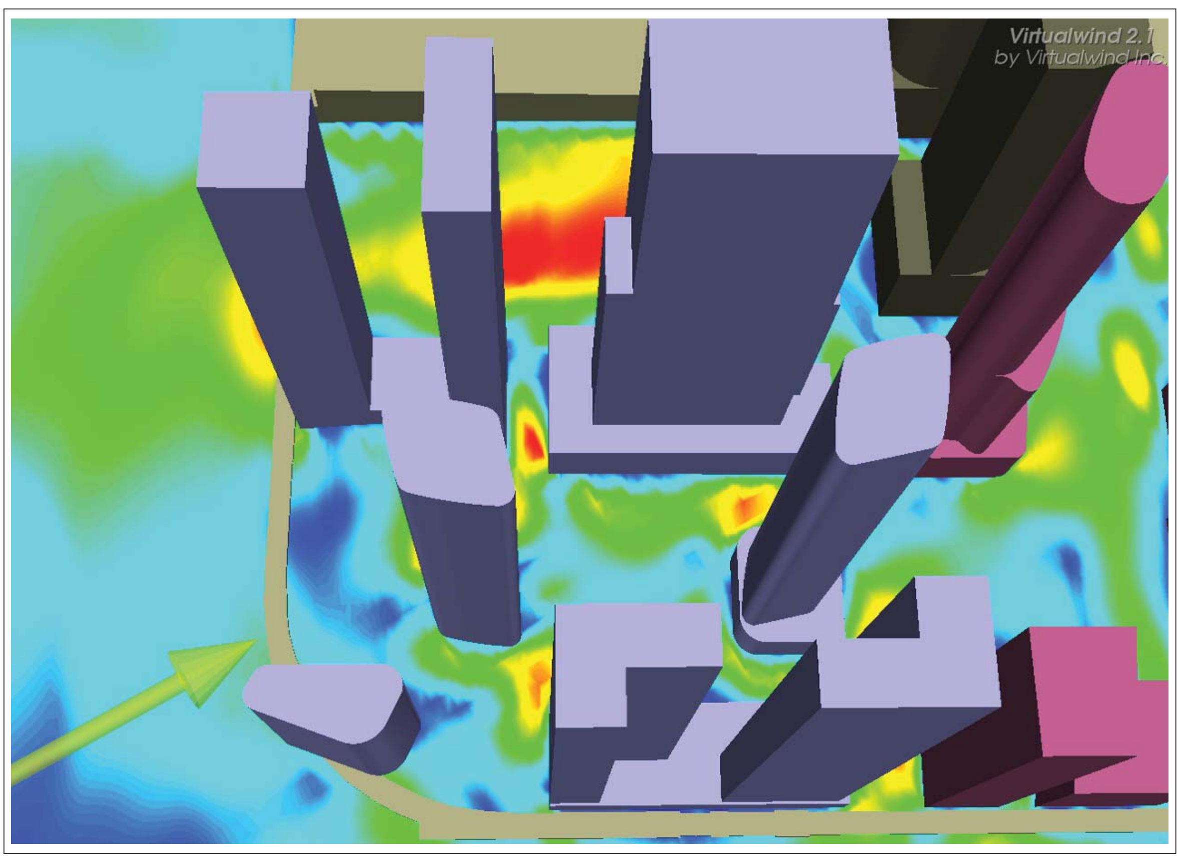
Project #0940081

Figure:	8a
Produced by:	ACM
Date Revised:	May 7, 2009

RWDI

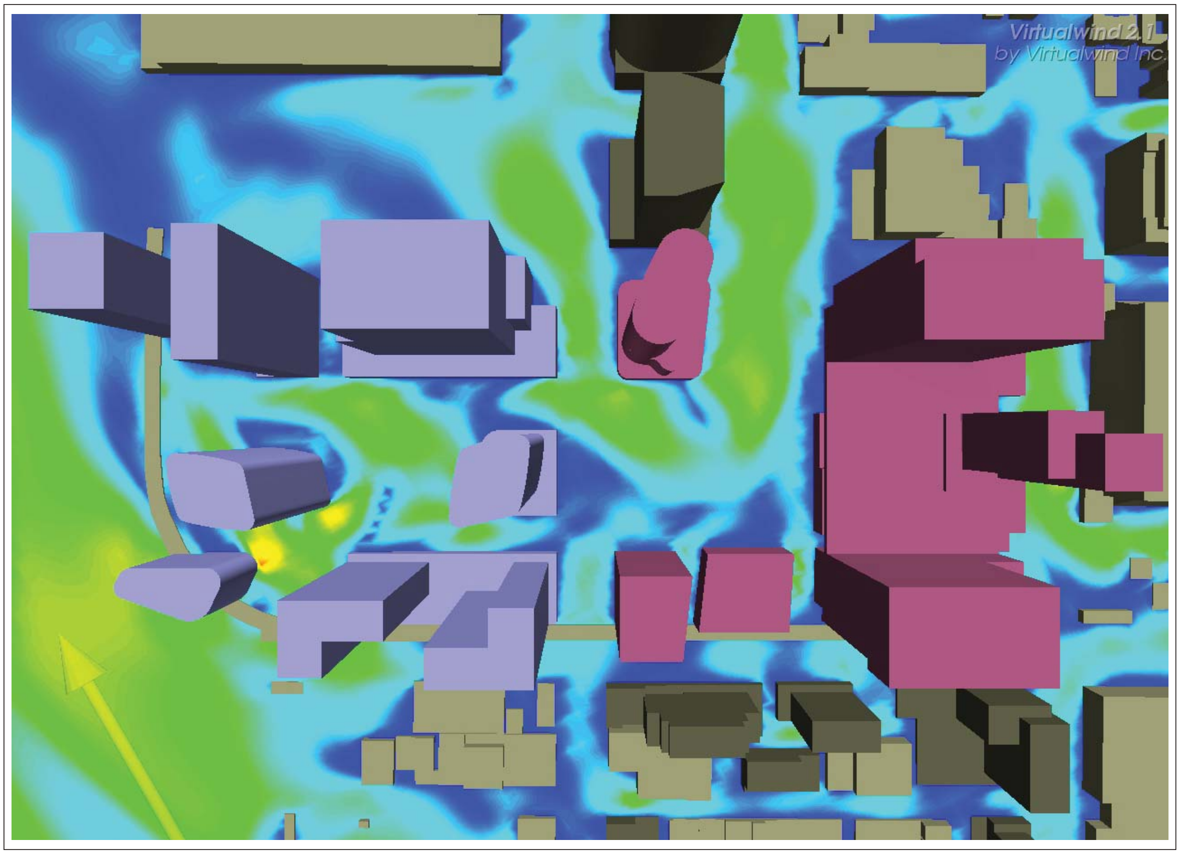


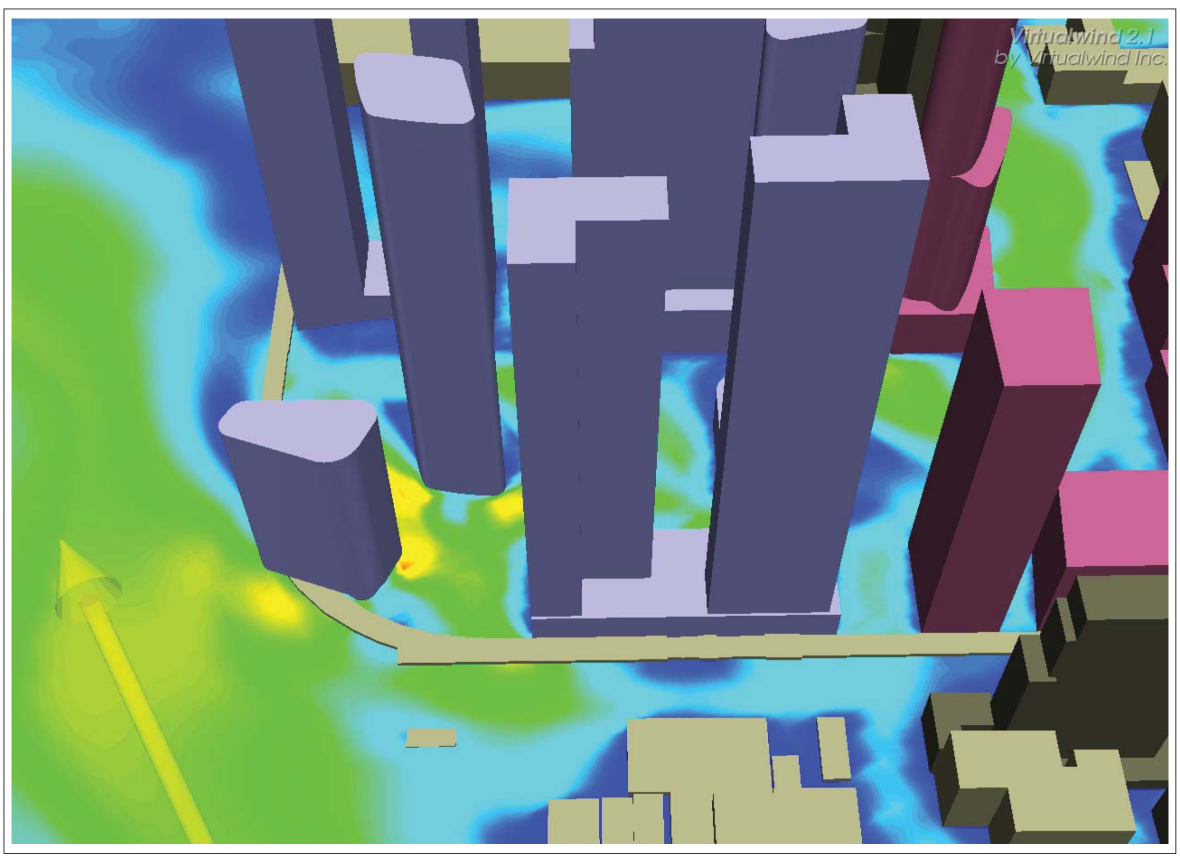
Low High
Wind Speed



Wind Simulation Results: Full-Build Configuration **Winds from the West**	Figure:	8b
	Produced by:	ACM
Western Rail Yard - New York, New York Project #0940081	Date Revised:	May 7, 2009

RWDI





Wind Simulation Results: Full-Build Configuration
Winds from the South

Western Rail Yard - New York, New York

Project #0940081

Figure:	8c
Produced by:	ACM
Date Revised:	May 7, 2009

RWDI

Key Areas of Interest for Pedestrian Wind Safety
Full-Build Configuration

Western Rail Yard - New York, New York

Reference North True North

Project #0940081

Drawn by: ACM	Figure: 9
Approx. Scale:	1"=250'
Date Revised:	May 11, 2009

RWDI