Intermunicipal Airport Master Plan Task Force
Air Pollution Considerations for the Master Plan

February 25, 2025

The Intermunicipal Airport Master Plan Task Force was formed by participating municipalities to identify issues of concern related to the upcoming revisions of the Master Plan for Westchester County Airport. The Task Force is composed of individuals from the following seven local communities: City of Rye, Village of Rye Brook, Village of Port Chester, Town of Greenwich, Town of New Castle, Town of North Castle, and Town of Rye. The individuals are volunteers selected by the elected officials in their municipalities who have varied backgrounds in local governance, land use planning, law, and engineering. The Master Plan topics of concern were each addressed in separate reports, with the understanding that there is overlap among some topics. The purpose of this report is to identify the chief sources, types, and quantities of air contaminants generated by the Westchester County Airport and make recommendations to our elected officials about the how these topics should be addressed in the Master Plan update. Then, with an understanding of prevailing wind direction and downwind receptors (e.g., residential areas, schools, water bodies), make an assessment of what types and levels of pollution currently exist. Finally, this report describes some possible factors that could mitigate or exacerbate airport-generated air pollution in the future. The Task Force hopes that these current and future air pollution issues will be considered and addressed where possible in the Master Plan.

Inventory of Current Sources, Types, and Quantities of Contaminants

The Westchester County Airport has conducted emissions inventories in 2007 and 2017 and reports were prepared summarizing the results. (Note that the most recent report is dated January 2021, but the inventory data is from 2017.) The limits of the 2017 inventory were the onsite operations controlled by the airport manager, Avports, Inc., and the aviation-related operations of airport tenants and vendors.[1] These include emissions from aircraft taxi movement and flight up to 3000 ft of altitude. The inventory is also limited to the following:

- six common greenhouse gases (GHG) which are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) and
- eight non-GHG emissions, which are nitrogen oxides, volatile organic chemicals, non-methane hydrocarbons (NMHCs), total hydrocarbons (other than NMHCs), sulfur oxides, and particulate matter (smaller than 10 and 2.5 microns, abbreviated PM_{10} and $PM_{2.5}$, respectively).

The calculations of emissions were conducted as outlined in the FAA Aviation Emissions and Air Quality Handbook[2] and the Transportation Research Board Airport Cooperative Research Program and therefore

[1] First Environment, "Westchester County Airport Air Emissions Inventory" (report prepared for Westchester County Airport, January 2021), https://airport.westchestergov.com/images/stories/pdfs/about/wcaeu2017airemissionsada.pdf, 1-49 (accessed July 13, 2024).
[2] FAA "Aviation Emissions and Air Quality Handbook," https://www.faa.gov/regulations_policies/policy_guidance/envir_policy/airquality_handbook (accessed July 13, 2024).

allow comparisons to operations at other airports. Emission sources were included based on what the report cites as "data availability and relevance" and therefore may not represent all air emissions from the airport, but are likely a good representation of the majority, including the more significant generators of pollutants of concern, although the report notes that lead and ozone are not included.

Of all emission sources at the airport, 86% are attributable directly to aircraft. The remaining sources include ground support equipment, auxiliary power units, boilers and furnaces, training fires, fugitive refrigerants, and rental cars. Of the 77,000 metric tons of GHGs associated with annual emissions, carbon dioxide composes over 99% of the total. Of the 1273 metric tons of non-GHGs, the majority (99%) is associated with aircraft. The non-GHGs are composed primarily of carbon monoxide (64%). The remainder in descending order of quantity includes nitrogen oxides, volatile organic chemicals, non-methane hydrocarbons (NMHCs), total hydrocarbons (other than NMHCs), sulfur oxides, and particulate matter less than 10 and 2.5 micrometers in diameter (PM_{10} and $PM_{2.5}$, respectively).

While the vast majority of all emissions are related to aircraft, it is important to note that, in 2009, the airport converted its ground support equipment fleet from gasoline and diesel-powered to pure electric-powered vehicles and, as a result, drastically reduced the second largest contributor to air pollution at the airport.[3]

The 2017 Air Emissions Inventory reports a 23% reduction in GHG emissions from the 2007 Inventory, corresponding to the reduction in aircraft operations during the corresponding period of time and balanced by an increase in the size of aircraft operating at the airport.

Still, with the majority of emissions being from aircraft, the breakdown of this source is important. The numbers of aircraft and flights contributing pollution are as follows:[4]

- 437 total takeoffs and landings per day on average (for period 12/31/21-12/31/22)
- 31 commercial flights in the above total
- 367 general aviation flights in the above total
- 39 air taxis in the above total

The numbers and types of the 284 aircraft based at the airport are as follows (as of July 11, 2024):

- 131 single engine airplanes
- 37 multi-engine airplanes
- 105 jets
- 11 helicopters

Leaded Aviation Fuel

The exclusion of lead from the emissions inventory reports is significant in that while commercial aircraft use Jet-A, an unleaded fuel, 75% of general aviation aircraft in the US, and more specifically the small piston-engine aircraft fueled at the airport (e.g., Cessna 402 and Raytheon Beech Baron 58) still use

[3]Air Quality at Westchester County Airport https://airport.westchestergov.com/about-us/environmental-management-system/air-quality (accessed July 12, 2024).
[4] AirNav: KHPN - Westchester County Airport, https://www.airnav.com/airport/KHPN (accessed July 12, 2024).

leaded AvGas, also known as '100LL." The "LL" stands for "low lead." Lead helps to boost fuel octane. In 2017, there were 27,474 operations (take-offs or landings) of AvGas-fueled planes at Westchester, or about 17% of all operations.

There is evidence that leaded fuel emissions cause harm.[5] Lead is a neurotoxin, to which children are especially susceptible and for which there is no known safe level of exposure. Therefore, deposition of lead from the aircraft at low altitudes in the vicinity of the airport is cause for concern, particularly when areas adjacent to the airport include residential areas, schools, and water supplies. Some reports on other airports note lead deposition occurs within 2000 ft of the end of airport runways.[6]

Based on the fuel summary provided in the 2017 emissions inventory by aircraft type, a total of 6.7 million gallons of fuel are consumed annually by all aircraft on the ground and in the perimeter takeoff and landing airspace (to 3000 ft of altitude). Of this amount, 98.6% is unleaded JetA versus 1.4% leaded AvGas. [7]

However, there is a movement within the industry to switch to unleaded fuels by 2030 for general aviation. In September 2022, the FAA approved an unleaded aviation fuel (G100UL) that will allow a large number of piston-engine airplanes to switch to unleaded fuel. In 2023, a high-octane option (100R) was also introduced. Therefore, the leaded fuel emissions at the airport are likely to decline over time. The Airport Cooperative Research Program, which is part of the Transportation Research Board is providing a guidebook to airports focused on the transition to unleaded fuels.[8]

Still, lead is a persistent contaminant that is adsorbed by soil particles. Therefore, despite these improvements in lowering the lead levels in fuel, the contamination that has occurred over decades on the surrounding properties will remain. It is unclear to what extent such contamination poses a threat to human health or the environment.

Prevailing Wind Direction and Receptors

The prevailing wind direction is from the west-northwest. Figure 1 shows the prevailing wind directions for the last 10 years.

Figure 2 shows the monthly variation of winds using observations from 2011 to 2024. This shows the lightest winds occurring in the summer months. Figure 2 also shows a wind rose overlaid on a map of the airport area. A red line is drawn to depict the area within 3000 ft of the airport in the primary downwind direction from the ends of the runways (Runways 16 and 34); the blue line shows the area within 3000 ft downwind of the airport runways in the less dominant wind direction. On descent,

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[5] "Final Finding that Lead Emissions from Aircraft Engines that Operate on Leaded Fuel Cause or Contribute to Air Pollution May Reasonably Be Anticipated to Endanger Public Health and Welfare," Federal Register, Vol. 88, No. 202, October 20, 2023, 72372-72404.

[6] "Understanding Airport Air Quality and Public Health Studies Related to Airports, Second Edition (2024), Summary of Findings," https://nap.nationalacademies.org/read/27886/chapter/2 (accessed July 13, 2024)

[7] First Environment, "Westchester County Airport Air Emissions Inventory" (report prepared for Westchester County Airport, January 2021), https://airport.westchestergov.com/about-us/environmental-management-system/air-quality (accessed July 12, 2024), 29.

[8] Building an Unleaded Future by 2030, https://www.faa.gov/unleaded#:~:text=Under%20the%20STC%20process%2C%20the,UL%2094%20/%20UL%2091%20fuels.

aircraft altitudes are about 270 ft at this 3000-ft perimeter based on FAA-directed glide paths.[9] Impacts likely extend beyond this boundary, but this limit was chosen here to identify some of the communities, water bodies, and land uses that are most immediately impacted. Some of the possible pollutant receptors in the dominant downwind area (red) include those located in portions of Purchase, NY; Rye Brook, NY; and Greenwich, CT; as follows (in order approximately from south to east of the airport):

- The Golf Club of Purchase
- State University of New York, Purchase College
- Blind Brook
- BelleFair residential community and Atria Rye Brook, a senior living community
- Corporate Office Park in Rye Brook (WHI Solutions, Chartwells Higher Education, Reckson Associates, Regus, Xylem, HOP Energy)
- Convent of the Sacred Heart, Greenwich, a private K-12 school (note the Brunswick Pre-K and Lower School, Greenwich, is located just north of the drawn red boundary line)
- Other single-family residences (throughout demarcated area)

Blind Brook is significant on this list in that the stream originates at the airport and has the potential to transport contaminants downstream along its length to Purchase, Rye Brook, and then Rye where it empties into Milton Harbor. Flooding that is known to occur along its length can further spread these contaminants laterally from the streambed onto adjacent properties.

As shown, the less dominant component of prevailing wind blowing to the northwest aligns with vectors for takeoff and landing paths northwest of the airport. In this impact area (blue), deposition of contaminants likely occurs to Rye Lake (which connects to Kensico Reservoir, part of the water supply system for New York City), as well as to nearby residences and small farms in West Harrison, Armonk, and Greenwich.

Note that these are only theoretical areas of impact. To our knowledge the airport has not conducted any downwind sampling or dispersion modeling. However, it is interesting to note that these theoretical areas overlap, at least in part, two other development-sensitive areas that have been designated near the airport:

- the Critical Environmental Area (CEA)---the CEA was established in 1990 by Westchester County Airport via the New York State Department of Environmental Conservation using the contour of the 1988 60-decibel Day-Night Level (DNL). The DNL is the 24-hr average of all noise activity.
- the Runway Protection Zone (RPZ)—a zone of FAA-protected land off the end of runways designated so as “to protect people and property on the ground in the event of an aircraft landing or crash beyond the runway end.”

Therefore, it would not be unprecedented (or necessarily burdensome due to the overlap) to add areas of environmental impact that should also be respected from a development standpoint.

Although data is lacking for specific emissions at Westchester, there are several studies which well document pollution impacts in the vicinity of other airports. In particular, a report prepared by ICF, Inc.,

[9] Instrument Landing System or Localizer Approach Runway 34, Westchester County (HPN), https://aeronav.faa.gov/d-tpp/2407

LLC, and members of the US EPA Office of Transportation and Air Quality, reviewed 70 available studies since 2000, which were focused on the impacts of commercial aircraft activity on air quality near airports.[10] These studies were primarily focused on particulate matter, especially ultrafine particles (UFPs, which are less than 100 nanometers (nm) in size and equate to less than 0.04 $PM_{2.5}$). Some studies showed aviation contributions to UFP air pollution 6 mi or more from the airports. It is worth noting that this distance approximately corresponds to the distance from the Westchester County Airport where aircraft on approach are required to reduce their altitude to 2000 ft and begin their final descents.[11]

Other studies have shown pollutant levels, particularly of fine PM, within airport terminals, with gate departure areas of terminals frequently showing the highest indoor pollutant levels.[12]

While not focused on health effects, the review noted that UFPs, due to their microscopic size, are of particular concern because they are readily absorbed into the lungs and bloodstream. The review also revealed that a number of studies cited adverse health effects in the vicinity of airports, including increased rates of premature death, pre-term births, decreased lung function, oxidative DNA damage, and childhood leukemia.[13]

Jet engine emissions were cited as having similar properties to diesel exhaust particles and other traffic emissions. There are significant differences, however. Traffic pollution is generated at ground level and people can even somewhat separate themselves from traffic pollution by vegetation and walls. Similar protection from airborne aircraft emissions is more limited. The FAA determines aircraft takeoff and landing routes and aircraft can disperse pollutants over a much wider area. Also, aircraft exhaust particles are much smaller in size---on the order of 13 nm vs. 35 nm for vehicle exhaust---making them a more potent contaminant.[14] Finally, while traffic emissions may be on the decline with the increase in electric vehicles, air travel is increasing. Therefore, the airport may have an increased relative role in the future air quality of the area.

Considerations for the Airport Master Plan

[10] Karie Riley, Rich Cook, Edward Carr, and Bryan Manning, "A Systematic Review of the Impact of Commercial Aircraft on Air Quality Near Airports," *City and Environment Interactions* 11 (May 4, 2021): 1-9. https://www.sciencedirect.com/science/article/pii/S2590252021000118 (accessed July 12, 2024).
[11] Instrument Landing System or Localizer Approach Runway 34, Westchester County (HPN), https://aeronav.faa.gov/d-tpp/2407
[12] "Understanding Airport Air Quality and Public Health Studies Related to Airports, Second Edition (2024), Summary of Findings," https://nap.nationalacademies.org/read/27886/chapter/2 (accessed July 13, 2024)
[13] Karie Riley, Rich Cook, Edward Carr, and Bryan Manning, "A Systematic Review of the Impact of Commercial Aircraft on Air Quality Near Airports" *City and Environment Interactions* 11 (May 4, 2021): 1-9. https://www.sciencedirect.com/science/article/pii/S2590252021000118 (accessed July 12, 2024).
[14] Jack. D. Griffin, "Electron Microscopic Characterization of Exhaust Particles Containing Lead Dibromide Beads Expelled from Aircraft Burning Leaded Gasoline," *Atmospheric Pollution Research*, Volume 11, Issue 9 (September 2020): 1481-1486.

There are several areas of concern presented in this white paper that were not previously addressed in the 2017 update to the Airport Master Plan.[15] These are identified below:

1. Lead emissions are not discussed. The 2017 update states that lead is one of the criteria pollutants under the Clean Air Act:

   The United States Environmental Protection Agency (EPA), through the 1970 Clean Air Act, has established National Ambient Air Quality Standards (NAAQS) for six pollutants (also known as "criteria pollutants"). These pollutants are regulated by EPA on the basis of information on health and environmental effects and include: ozone (O3), nitrogen dioxide (NO2), carbon monoxide (CO), sulfur dioxide (SO2), particulate matter (PM), and airborne lead (Pb). The 1977 and 1990 Clean Air Act Amendments reinforced attainment and maintenance of these standards.

   However, lead is not included in the emissions inventories conducted by the airport.

2. Emissions inventories cited in the update are theoretical and not based on actual sampling or airport-specific modeling. Thus, there are no actual data on which to base an assessment of impacts or the need for improvements relative to air pollution.

3. The 2017 update does not include some reduction strategies that are now possible or in use. The 2017 update cites the conversion of ground support equipment to electric and the pursuit of alternative fuels for boilers. These are highly effective and laudable improvements. However, there are other improvements that were not promoted, some of which are now in use, such as requiring the use of ground power units (GPUs) for all aircraft parked at gates.

4. The 2017 update mentions the County's status under the EPA National Air Quality Attainment Standards as being in the "moderate non-compliance" category for ozone and potentially being de-designated as being non-compliant for $PM_{2.5}$ without discussing relevance to the airport. Note that current EPA reporting shows the County still non-compliant for ozone, but compliant for $PM_{2.5}$.[16] However, there is no context presented for if or how the airport contributes to the County's status or whether the required State Implementation Plan (SIP) includes any provisions relevant to the airport. Note that the regular emissions inventories prepared by Avports do not include ozone and there is no known air sampling at the airport. Without estimates or data specific to the airport, this section of the 2017 update is incomplete.

Based on the above, there are several important conclusions and recommendations below that that are relevant to the new Airport Master Plan. Not all may be within the scope of the Plan, but that does not diminish their relevance or importance. We recognize that we have used the "Plan" term broadly here and that some work may be better performed in auxiliary or preparatory studies. We also note that

[15] DY Consultants, "Westchester County Airport Master Plan Update, Chapter II: Environmental Overview, Final Report," (December 2017), https://airport.westchestergov.com/images/stories/masterplan/04Chap2EnviOrviewFNLDec17.pdf (accessed August 31, 2024), 2-4.

[16] New York Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants, https://www3.epa.gov/airquality/greenbook/anayo_ny.html (accessed August 31, 2024).

many of these recommendations are consistent with or complementary to those made by the Westchester County Airport Advisory Board in 2021:

1. Conduct the studies needed to determine offsite areal extent and impact. The air emissions inventories conducted by the Airport, while following standard procedures, are limited in scope and usefulness in evaluating airport-generated air pollution. The offsite extent and concentration of impact corresponding to the inventory's boundary of 3000 ft of aircraft altitude are not defined. Dispersion of contaminants, with lead and ultrafine particles being of particular concern, is likely occurring beyond the area directly below aircraft at this altitude. The Plan should incorporate air and soil sampling and dispersion modeling. Even dispersion modeling alone would be useful in that it would allow conversion of the calculated emissions into quantified impacts to the surrounding area.

   Any discussion of the National Air Quality Standards should be revised to more clearly discuss how the airport contributes or not to the County's attainment or non-attainment of those standards.

2. Gather and share the current research around aircraft-generated pollution and produce guidance. Land use planning authorities in the surrounding communities have allowed residential construction near the airport contrary to County Planning Department recommendations. In part, this may be because there is no clear, comprehensive guidance for what land planning reviews should include relative to the CEA, RPZ, and emission concerns. Local land planning authorities may benefit from new information regarding the impacts that proximity to airport operations can have on the well-being of future residents. More pro-active efforts to educate and impress the impacts of these operations on nearby developments should be encouraged.

   For example, guidance could be created that is similar to the Environmental Assessment Form (EAF) Workbooks currently used by applicants and agencies to comply with the New York State Environmental Quality Review Act. The Workbooks contain instructions, background related to each EAF question, and links to spatial data, maps, and illustrations. The scope and use of these Workbooks ends at the point the lead agency makes either a positive or negative determination of significance. Similarly, an "HPN Land Use Guidance Document" could include the current flight path, air pollution, noise, stormwater, groundwater, RPZ, and any other data that should be impact a land use decision. Use of such guidance would encourage more thorough, appropriate, and consistent land use reviews.

3. Devise ways to incentivize reductions in pollution by commercial and general aviation users. The Task Force recognizes that Avports has little to no control over aircraft emissions sources. At best, Avports can influence the owners of these sources through best operational practices, such as incentivizing the use of aircraft engines and vehicles meeting the strictest emission standards, operating on fuels with the lowest emissions, and other operational practices. To the extent within its authority, the airport should consider incentives such as reducing landing fees for aircraft using unleaded fuel and increasing fees for those using AvGas.

4. Plan for improvements in the terminal building to limit exposure to pollutants entering the space. The Plan should ensure proper heating, ventilation, air conditioning, and air filtration systems are in place to protect passengers and terminal workers from pollution in the gate areas. This is particularly important for passengers now with more seating being offered in the immediate vicinity of gate

doors. Future space planning should better isolate openings to airplanes from waiting passengers and workers to prevent air pollution from entering the terminal. Continuing to require aircraft parked at gates to use GPUs also helps reduce this pollution.

5. Seek to control the primary airport emissions, which are associated with aircraft. The Plan should focus on continuing to limit the number of commercial flights in accordance with current Terminal Use Agreements. The Plan should study the balance between reducing the number of aircraft operations and the size of aircraft to determine if there is a correlation between these factors and air emissions from aircraft activity. The Plan should also not allow for an increase in the number of FBOs and ensure that lease agreements with FBOs be carefully crafted to limit the numbers of flights (such as ensuring no private air services offer what should be classified as commercial service).

6. Anticipate the changeover of infrastructure from leaded AvGas fuel to an unleaded alternative for piston-engine aircraft. Fuel is centrally supplied at the airport, then distributed by fuel trucks to aircraft at the central terminal and FBOs. Therefore, for a time, there will be a need to provide space and services related to storage of both types of fuel. The Plan should explore commercially and physically viable measures to facilitate the transition to unleaded aviation fuel. Toward this end, the Plan should follow guidance being developed by the Airport Cooperative Research Program.

Conclusions

Ultrafine particles and lead are emerging contaminants of concern in aircraft exhaust at airports across the country. In light of the sensitive land uses near Westchester County Airport (e.g. residential, school, water supply), recommendations for the next master plan include the following:

1. Future studies of aviation emissions and air quality at the airport should include identification and quantification of other relevant contaminants, such as lead, ultra-fine particles, and ozone. Effort should be made to establish indoor (terminal) and offsite impacts of contaminants.

2. Studies that did not include Westchester County Airport, showed that pollutant levels within the airport terminals can be high, with the gate departure areas frequently showing the highest poor indoor pollutant levels. Methods of reducing this pollution should be investigated, including requiring aircraft parked at the gates to use ground power units instead of jet-fuel consuming auxiliary power units.

3. Steps should be taken to ensure Westchester County Airport has the facilities to support the full conversion to unleaded fuel by general aviation users.

4. The airport and County should provide outreach, share findings, and create actionable, airport-specific environmental assessment guidance for surrounding communities to better inform them of airport impacts on new projects.

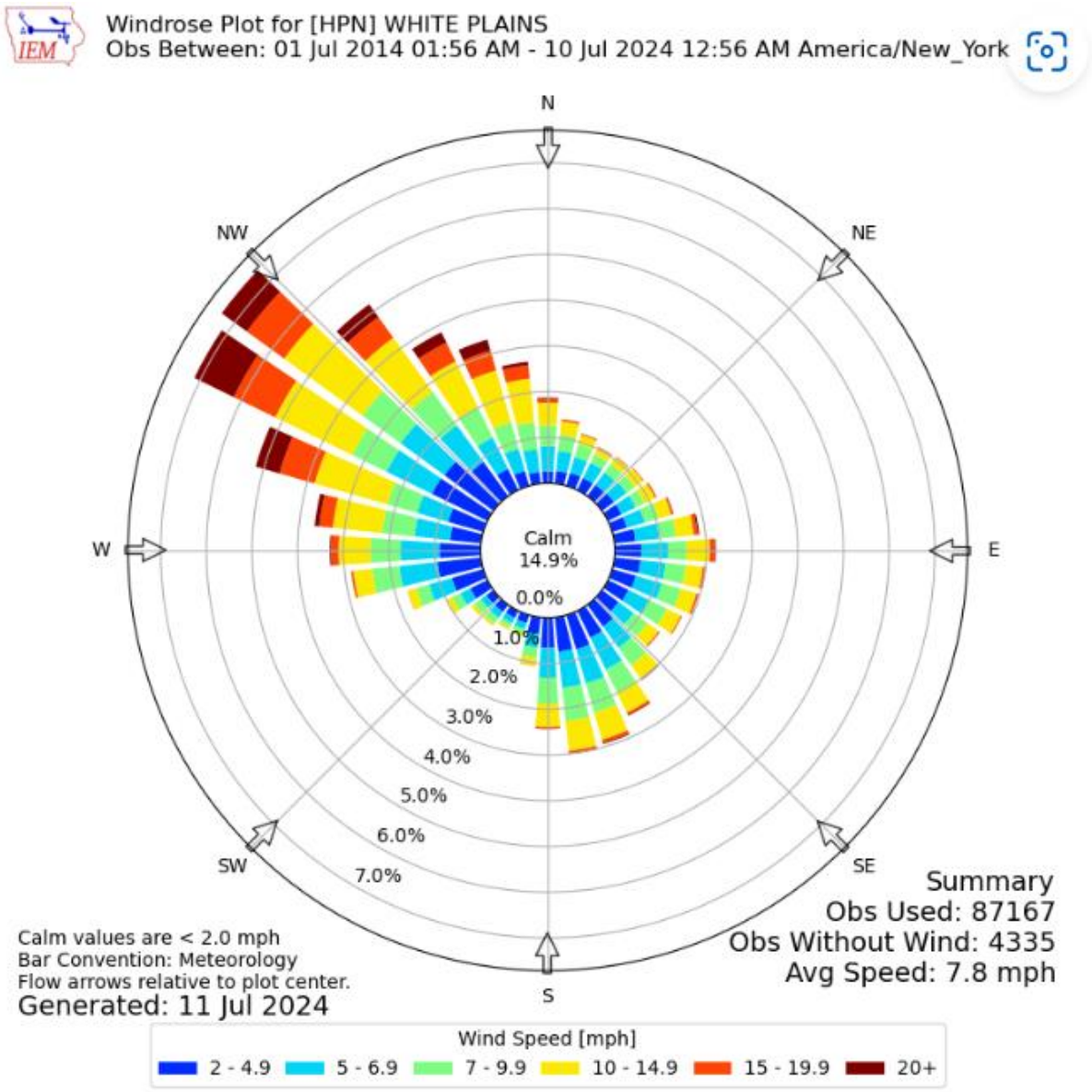

Figure 1---Composite Windrose for Westchester County Airport, July 2014 to July 2024.[17]

[17] Windrose Westchester County Airport, IEM :: Custom Wind Roses (iastate.edu) https://mesonet.agron.iastate.edu/sites/dyn_windrose.phtml?station=HPN&network=NY_ASOS&staticrange=0&bin0=2&bin1=5&bin2=7&bin3=10&bin4=15&bin5=20&conv=from&units=mph&nsector=36&fmt=png&dpi=100&year1=2014&month1=7&day1=1&hour1=0&minute1=0&year2=2024&month2=7&day2=10&hour2=0&minute2=0 (accessed July 10, 2024)

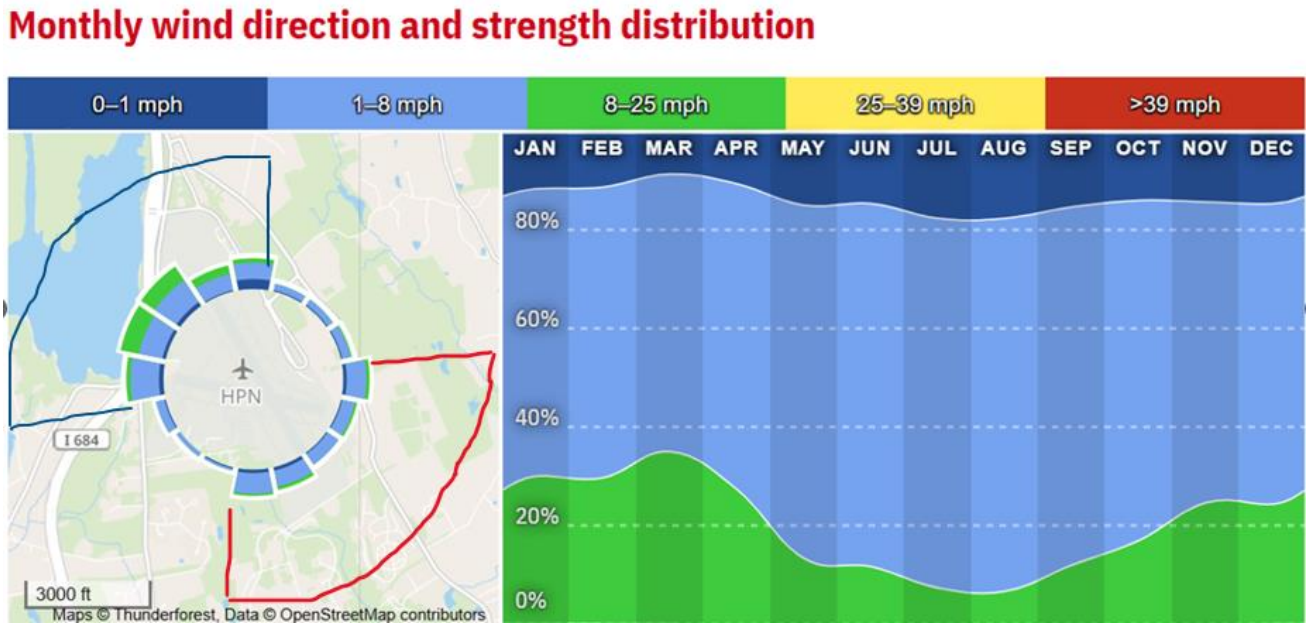

Figure 2---Monthly Wind Direction and Strength at Westchester County Airport, October 2011 to June 2024.[18] Red line added to show primary downwind impact area within 3000 ft of airport; blue line added to show area of less dominant wind impact to the northwest. These areas also align with the takeoff/landing paths for the two major airport runways, which can be seen in light blue.

[18] Monthly Wind Direction and Strength at Westchester County Airport, Observations Taken Between October 2011 and June 2024, Wind & weather statistics Westchester County Airport - Windfinder, https://www.windfinder.com/windstatistics/westchester_county_airport (accessed July 10, 2024).