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RE: Case Number 16-1871 EL BGN Icebreaker

Please consider the following submission as it relates to the Icebreaker Wind Turbine project as proposed in close proximity to the Burke Lakefront Airport, Cleveland Ohio.

When traveling by air, the most dangerous portion of a flight is when the aircraft is closest to, or at, an airport. According to Transport Canada, in Canada, 87% of aircraft accidents happen at or near airports.

Needless to say, introducing 500 ft high obstacles within the airspace of any airport poses significant safety risks. Statistically, it is within 15 miles of an airport that aircraft are in the "riskiest" phases of flight and may encounter problems that jeopardize air safety.

Transport Canada data indicates that in the decade between 2002 and 2011, there were an average of 357 aircraft accidents per year in Canada and almost half of them occurred during attempted landings.

This does not take into consideration incidents that didn't result in an accident but could have. When an aircraft gets into trouble, it needs to land as soon as possible at the nearest suitable airport. Between 2002 and 2011, according to Transport Canada, there were 5,860 incidents that required pilots to make emergency landings at a Canadian airport. Clearly, the imposition of 500 ft structures with 300 ft diameter whirling blades in the vicinity of an airport would significantly increase the risk of serious accidents.

There is growing hard evidence supporting fears that industrial scale wind turbines are a real aviation hazard, and at least some local airport authorities and local jurisdictions are taking action.

In the neighboring Province of Ontario, which shares the airspace overhead of this proposed off-shore project, a recent ruling in a 2016 ERT hearing (Wiggins vs Ontario Case No 16-036) stated that locating obstacles in the proximity of an aerodrome, or that airspace unutilized by aircraft in flight, will cause irreversible harm to human health.

The Tribunal's ruling relied on Transport Canada directive TP1274E to understand the aviation risks associated with siting wind turbines. Its introduction, TP1274E reads:

> *'Municipal planners and developers must understand that how land is used around an aerodrome will have an impact on the aerodrome's operations. The land use around aerodromes can have significant impacts on safety at the aerodrome and can negatively impact the operational viability of the aerodrome to the detriment of the local community that depends upon it.*
> *Note: It is of the utmost importance to be aware that the proximity of obstacles, for example wind turbines, telecommunications towers, antennae, smoke stakes, etc., may potentially have an impact on the current and future usability of an aerodrome.*

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> *Therefore, it is critical that planning and coordination of the siting of obstacles should be conducted in conjunction with an aerodrome operator at the earliest possible opportunity.'*

Expert witnesses provided testimony, supported by statistical studies, as to the effect of wind turbine turbulence. This is an area of expertise that is undergoing much study with the introduction of wind energy in North America. All experts agree that wind turbulence is created in the turbines' wake but the effects are unknown, however, when compared to aircraft or helicopter wake turbulence, turbine turbulence will be catastrophic if encountered by an aircraft in flight.

A study, entitled *Wind Farms Turbulence Impacts on General Aviation*, released January 18, 2014, by University of Kansas researcher, Prof. Tom Mulinazzi, finds that wind turbines could be hazardous for small aircraft. The study was done for the Kansas Department of Transportation.

According to Mulinazzi, wind turbines can set up a circular vortex that can roll a plane if it gets caught in it. A second problem, Mulinazzi says, is that wind turbines can increase crosswind speeds above what's expected, which can be a real danger to small aircraft, which don't typically take off and land with crosswinds stronger than about 20 km per hour.

The study was commissioned after the Kansas Transportation Department's aviation division started receiving a large number of reports from pilots complaining that they were experiencing unusual turbulence as they flew near wind farms. Mulinazzi and his team found that the higher the wind speed, the farther the turbulence reached – stretching almost 5 km from a single turbine – before dissipating.

Even before release of the Mulinazzi study, a coalition of pilots using the airport in Pratt, Kansas, had petitioned against plans for a wind farm to be built within 5 km of the airport runway. Part of their objection was the possibility the turbines would create winds causing dangerous turbulence.

Mulinazzi's team looked at the pilots' concerns at Pratt and another airport 8 km south of Stockton, Kansas. Researchers concluded that at both airports, pilots could potentially encounter a crosswind or "roll upset" generated from a wind turbine. Subsequently, according to Reid Bell, manager at the Pratt Airport, the Pratt wind farm project was relocated farther away from the airport. In addition, city officials approved an ordinance protecting airspace around the airport from any future wind farm hazard.

Meteorological Conditions will also elevate a flights risk assessment when in operating from an aerodrome in close proximity to obstacles. The Cleveland Burke Lakefront Airport is inherently susceptible to low visibility flight conditions due to its geographical location on the shores of Lake Erie within the chain of Great Lakes. These reduced flight visibility conditions can lead to pilots finding themselves in situations where they must decent to very low altitudes above the

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surface of the lake to maintain visual contact with the ground enabling them to safely land at Burke field. Wind turbines masked by the back drop of cloud and water will most certainly be cause for a pilot to be unable to avoid the obstacle in time once it becomes visible.

Human factors are one of the most common, leading causes in aviation accidents. Pilot Error is to be human. Humans still operate aircraft in an environment of 'see and avoid' or 'navigate and avoid'. It is proven that when a pilot operates in close proximity to obstacles the flight risk of controlled flight into terrain goes up exponentially. Burke lakefront airport is virtually free of this added obstacle flight risk. Again, I reference TP 1274E.

The land use around aerodromes can have significant impacts on safety at the aerodrome and can negatively impact the operational viability of the aerodrome to the detriment of the local community that depends upon it.

The aviation community recognizes that it is prone to deviations from published procedures on occasion. This is why the U.S.A. Department of Transport factors in deviation errors when designing flight procedures. An aircraft in flight cannot be brought to a stop or reversed so as to adjust its flight trajectory. The introduction of obstacles only goes to narrow the deviation protection of error to the point that the risk of collision is imminent, should the smallest of deviation occur due to factors beyond a flight crews' control or awareness.

Cleveland and the surrounding area depends on the Burke Lakefront Airport. Likewise, this community relies on the State of Ohio to adopt appropriate protocol in protecting public safety, and proven safe operating transportation infrastructure, when engaging in renewable energy projects. I urge you to act in the public interest in protecting your community, preserving aviation safety and preventing harm to human health by not approving wind turbines within a 15 NM radius of the Burke Lakefront Airport.

Thank you.

Kevin Elwood
Southern Ontario Director - Canadian Owners and Pilots Association
Airline Transport Pilot
Owner Operator - Clearview Aerodrome
Councillor Ward 2 - Clearview Township
President - Aeroshelter

Environmental Review Tribunal
Tribunal de l'environnement

Ontario

ISSUE DATE: October 07, 2016 **CASE NO.:** 16-036

PROCEEDING COMMENCED UNDER section 142.1(2) of the *Environmental Protection Act*, R.S.O. 1990, c.E.19, as amended

Appellant:	See Appendix 1 – Appellant List
Approval Holder:	wpd Fairview Wind Incorporated
Respondent:	Director, Ministry of the Environment and Climate Change
Subject of appeal:	Renewable Energy Approval for Fairview Wind Project
Reference No.:	3948-9RDLRF
Property Address/Description:	various sites
Municipality:	Township of Clearview
Upper Tier:	County of Simcoe
ERT Case No.:	16-036
ERT Case Name:	Wiggins v. Ontario (Environment and Climate Change)

Heard: May 16 to 19, and May 30 to June 3, 2016 in Collingwood, Ontario

APPEARANCES:

Parties	**Counsel/Representative**+
John Wiggins	Eric Gillespie and Priya Vittal
Kevin Elwood, Gail Elwood and Preserve Clearview Inc.	Konstantine J. Stavrakos
Corporation of the County of Simcoe and Town of Collingwood	Julie Abouchar, Richard Butler and Nicole Petersen
Corporation of the Township of Clearview	Harold Elston and Aynsley Andersen

wpd Fairview Wind Incorporated	John Richardson and Nedko Petkov
Director, Ministry of the Environment and Climate Change	Andrea Huckins and Sylvia Davis

Participant

Canadian Owners and Pilots Association	Glenn Grenier

Presenters

Collingwood Flying Club	George E. Daniels+
Susan Richardson, Mandy Bridson, Stephen Bridson, and Elizabeth Marshall	Self-represented

ORDER DELIVERED BY DIRK VANDERBENT AND HUGH S. WILKINS

REASONS

Background

[1] On February 11, 2016, Mohsen Keyvani, Director, Ministry of the Environment and Climate Change ("MOECC") issued Renewable Energy Approval No. 3948-9RDLRF (the "REA") to wpd Fairview Wind Incorporated (the "Approval Holder"), granting approval for the construction, installation, operation, use and retiring of a Class 4 wind facility with eight wind turbines and a total name plate capacity of 16.4 megawatts (the "Project"). The Project is proposed to be located in Clearview Township, Simcoe County, Ontario (the "Project site").

[2] On February 19, 2016, John Wiggins, and on February 26, 2016, Gail Elwood, Kevin Elwood, Preserve Clearview Inc., the Corporation of the County of Simcoe ("Simcoe"), the Corporation of the Township of Clearview ("Township of Clearview"), and the Town of Collingwood ("Collingwood") (jointly "the Appellants") appealed the REA to the Environmental Review Tribunal (the "Tribunal") under s. 142.1(2) of the

Environmental Protection Act (“*EPA*”). Each Appellant appealed on the grounds that the Project will cause serious harm to human health and serious and irreversible harm to plant life, animal life and the natural environment.

[3] In overview, respecting harm to human health, it is the Appellants’ position that the proposed location of the wind turbines, which are in close proximity to the takeoff and landing areas of two aerodromes, the Collingwood Regional Airport (“CRA”) and Clearview Field, Stayner (“Clearview”), will result in airplane accidents that will result in serious injury or death. The Director and the Approval Holder disagree. Respecting serious and irreversible harm to animal life, the Appellants take the position that the proposed wind turbines in the Project will result in collision mortalities for hibernating bat species, including little brown myotis (*Myotis lucifugus*), northern myotis (*Myotis septentrionalis*), and eastern small-footed myotis (*Myotis leibii*), which are all listed as endangered under the *Endangered Species Act, 2007* (“*ESA*”). The Appellants maintain that such collision mortalities will further accelerate the decline of these species’ populations, and further reduce their numbers in the vicinity of the Project site leading to local extirpation. Again, the Director and the Approval Holder disagree.

[4] The parties completed the presentation of their evidence in the main hearing on June 3, 2016. The Tribunal subsequently issued an Order, dated June 16, 2016, adjourning the proceeding for 64 days under O. Reg. 359/09, s. 59(2)1.ii. In light of this adjournment, under s. 145.2.1(6) of the *EPA* the due date for disposing of this hearing was revised to October 21, 2016.

[5] For the reasons that follow, the Tribunal finds that the Appellants have satisfied the health and environment tests under s. 145.2.1(2)(a) and (b) of the *EPA* and further adjourns this hearing under O. Reg. 359/09, s. 59(2)1.ii to determine the next steps in this proceeding.

Relevant Legislation

[6] The following provisions of the *EPA* set out the jurisdiction of the Tribunal respecting these appeals, the onus of proof of the Appellants and the discretionary remedial powers of the Tribunal if it determines that engaging in the Project in accordance with the REA will cause the prescribed harm.

[7] ***Environmental Protection Act***

Interpretation

1. (1)

In this Act,

“natural environment” means the air, land and water, or any combination or part thereof, of the Province of Ontario;

…

PART I
ADMINISTRATION

Purpose of Act

3. (1) The purpose of this act is to provide for the protection and conservation of the natural environment.

…

PART XIII
APPEALS TO TRIBUNAL

…

Hearing re renewable energy approval

142.1 (1) This section applies to a person resident in Ontario who is not entitled under section 139 to require a hearing by the Tribunal in respect of a decision made by the Director under section 47.5.

Same

(2) A person mentioned in subsection (1) may, by written notice served upon the Director and the Tribunal within 15 days after a day prescribed by the regulations, require a hearing by the Tribunal in respect of a decision made by the Director under clause 47.5 (1) (a) or subsection 47.5 (2) or (3). …

Grounds for hearing

(3) A person may require a hearing under subsection (2) only on the grounds that engaging in the renewable energy project in accordance with the renewable energy approval will cause,

(a) serious harm to human health; or

(b) serious and irreversible harm to plant life, animal life or the natural environment.

…

Hearing required under s. 142.1

145.2.1 (1) This section applies to a hearing required under section 142.1.

What Tribunal must consider

(2) The Tribunal shall review the decision of the Director and shall consider only whether engaging in the renewable energy project in accordance with the renewable energy approval will cause,

(a) serious harm to human health; or

(b) serious and irreversible harm to plant life, animal life or the natural environment.

Onus of proof

(3) The person who required the hearing has the onus of proving that engaging in the renewable energy project in accordance with the renewable energy approval will cause harm referred to in clause (2) (a) or (b).

Powers of Tribunal

(4) If the Tribunal determines that engaging in the renewable energy project in accordance with the renewable energy approval will cause harm referred to in clause (2) (a) or (b), the Tribunal may,

(a) revoke the decision of the Director;

(b) by order direct the Director to take such action as the Tribunal considers the Director should take in accordance with this Act and the regulations; or

(c) alter the decision of the Director, and, for that purpose, the Tribunal may substitute its opinion for that of the Director.

Same

(5) The Tribunal shall confirm the decision of the Director if the Tribunal determines that engaging in the renewable energy project in accordance with the renewable energy approval will not cause harm described in clause (2) (a) or (b).

Deemed confirmation of decision

(6) The decision of the Director shall be deemed to be confirmed by the Tribunal if the Tribunal has not disposed of the hearing in respect of the decision within the period of time prescribed by the regulations.

Issues

[8] The issues to be determined on this appeal are:

1. Whether engaging in the Project in accordance with the REA will cause serious harm to human health; and
2. Whether engaging in the Project in accordance with the REA will cause serious and irreversible harm to bats.

Discussion, Analysis and Findings

[9] The Tribunal has considered all the evidence and submissions of the parties in detail. As these written materials exceed 2,000 pages, the Tribunal has reproduced only the evidence and salient submissions necessary to explain the Tribunal's reasons for its disposition of these appeals.

Issue No. 1: Whether Engaging in the Project in Accordance with the REA will cause Serious Harm to Human Health

Evidence

Expert Witnesses

[10] The Tribunal qualified the following witnesses to give opinion evidence on behalf of the Appellants, Simcoe and Collingwood:

- Charles Cormier, who was qualified to give opinion evidence as an expert in instrument flight procedures including take-offs and approaches, and in aviation safety, including qualitative assessments of the impacts and risks of obstacles on take-offs and approaches;

- David Gascoine, who was qualified to give opinion evidence as a person experienced in the area of flight and safety training and conditions at the CRA;

- Lee Heitman, who was qualified to give opinion evidence as an experienced commercial pilot with experience in aviation and safety management systems evaluation;

- Douglas McKechnie, who was qualified to give opinion evidence as an experienced commercial pilot and person who has significant experience in training pilots to identify, respond to and recover from emergencies;

- Dennis Moore, who was qualified to give opinion evidence as an expert in evaluating airport operation safety, including quantitatively assessing risk of hazards to air navigation; and

- Adam Dershowitz, who was qualified to give opinion evidence as an expert in aeronautical engineering, including aviation risk and pilot decision-making.

[11] The Tribunal qualified the following witnesses to give opinion evidence on health issues on behalf of the Appellants, Kevin and Gail Elwood and Preserve Clearview Inc.:

- Mr. Cormier, who was qualified as noted above;

- William Duncan, who was qualified to give opinion evidence as an expert in aeronautical engineering, aviation safety and flight data analysis and aviation safety training;

- Kerry Hutton, who was qualified to give opinion evidence as an expert in aerospace engineering, aviation safety and flight data analysis, air accident and incident investigations and aviation animation, air accident and incident re-creation;

- Charles Pereira, who was qualified to give opinion evidence as an expert in aeronautical engineering, including aircraft performance, aviation safety and accident investigations; and
- Keith Green, who was qualified to give opinion evidence as an expert in Aviation Safety Management Systems (SMS), inclusive of Hazard and Risk Assessment, and aerodrome/airport safety.

[12] The Tribunal qualified the following witness to give opinion evidence on behalf of the Appellant, Township of Clearview:

- Randy Mawson, who was qualified to give opinion evidence in the area of forensic climatology, including the impacts on aviation and aircraft.

[13] The Tribunal qualified the following witness to give opinion evidence on behalf of the Participant, Canadian Owners and Pilots Association:

- Conrad Hatcher, who was qualified to give opinion evidence as an aviation expert and, more specifically, as an expert in civil aviation as it relates to pilot training, aircraft operations and general aviation safety, including the conduct of safe operations in the aerodrome environment.

[14] The Tribunal qualified the following witnesses to give opinion evidence on behalf of the Approval Holder:

- Edward McDonald, who was qualified to give opinion evidence with respect to aviation, including instrument flight rule and visual flight rule operations, and instrument approach design inclusive of the identification of hazards; and
- Anthony Cox, who was qualified to give opinion evidence as an expert in the area of risk assessment in public safety, energy and transport as well as fluid dynamics and turbulence.

[15] The Tribunal qualified the following witness to give opinion evidence on behalf of the Director of the MOECC:

- David Simpson, who was qualified to give opinion evidence as an expert in instrument flight procedure design and instrument flight procedure maintenance for aerodromes, airports and en route structures.

The Federal Aviation Regulatory Regime

[16] The federal government regulates aviation under the *Aeronautics Act* and the *Canadian Aviation Regulations* ("CARS"). These are administered by Transport Canada which is a federal government department. NAV CANADA is a federally incorporated corporation that provides air navigation services in Canada, pursuant to the *Civil Air Navigation Services Commercialization Act*. Pursuant to this Act, NAV CANADA provides air navigation services in Canada, including aeronautical information, air traffic control, aviation weather reporting, and flight information to pilots.

[17] Transport Canada publishes standards, and, as well, issues guidance documents. These include documents on land use in the vicinity of aerodromes (for example, TP1247E - "Aviation - Land Use in the Vicinity of Aerodromes" ("TP1247E")) and standards and recommended practices (for example, TP312 - *Aerodrome Standards and Recommended Practices* ("TP312")). NAV CANADA also publishes the *Canada Flight Supplement,* which is an aerodrome directory that provides data and sketches of Canadian aerodromes and airports.

[18] Under the federal regime, an aerodrome is any location where planes take off or land. Aerodromes may be registered with Transport Canada, but are not required to be. However, all aerodromes must comply with CARS, Part III Subpart 1. Registered aerodromes are included in the *Canada Flight Supplement*.

[19] Although the terms "aerodrome" and "airport" are sometimes used interchangeably, they mean different things. An "airport" must be certified by Transport

Canada. They are required to comply with CARS Part III, Subpart 2 and TP312. TP312 states:

> These standards complement subpart 302 of the *Canadian Aviation Regulations* (CARs). They set out requirements such as: physical characteristics, obstacle limitation surfaces, visual aids and technical services the aerodrome operator at a certified land aerodrome (airport) provides to support aircraft operations. Other standards, established under Part III of the CARS form part of the overall safety specifications to satisfy the requirements of aerodrome certification.

The operational requirements for an airport are therefore more stringent than those for an uncertified aerodrome.

[20] Until 2007, the CRA held airport certification, but then relinquished this designation. Although it is still named the Collingwood Regional *Airport* (emphasis added), the CRA has, since then, continued to operate only as an uncertified aerodrome. Clearview has never been certified. Neither CRA nor Clearview have an air traffic control service. They each have uncontrolled airspace.

[21] Regarding land-use planning, in respect of airports, federal airport zoning regulations can only be enacted under the *Aeronautics Act*. Such zoning regulations may restrict or prohibit activities and uses. Again, because CRA and Clearview are not airports, there are no such zoning regulations in respect of these two aerodromes. Transport Canada issued TP1274E to inform planners and others on how specific land uses may impact aerodromes. In its introduction, TP1274E states:

> Municipal planners and developers must understand that how land is used around an aerodrome will have an impact on the aerodrome's operations. The land use around aerodromes can have significant impacts on safety at the aerodrome and can negatively impact the operational viability of the aerodrome to the detriment of the local community that depends upon it.

[22] TP1247E specifically addresses wind turbines. It states, in Part 6, that wind turbines are obstacles that require marking and lighting in accordance with Transport Canada's standards. It also notes potential challenges that wind turbines may have on

persons using radar systems, and navigation and communication systems. Regarding obstacle impacts, TP1247E emphasizes (in bold type):

> **Note: It is of the utmost importance to be aware that the proximity of obstacles, for example, wind turbines, telecommunications towers, antennae, smoke stacks, etc., may potentially have an impact on the current and future usability of an aerodrome. Therefore, it is critical that planning and coordination of the siting of obstacles should be conducted in conjunction with an aerodrome operator at the earliest possible opportunity.** (emphasis in the original)

However, TP1247E does not make any specific recommendations regarding the placement of wind turbines in proximity to aerodromes.

[23] In summary, all airports are aerodromes, but not all aerodromes are airports. Under the CARS, airports must comply with TP312, but aerodromes do not. Nonetheless, implementing TP312's requirements is considered a best practice to promote air navigation safety at an aerodrome. CRA, when it was an airport, complied with these requirements, and, based on the evidence before the Tribunal, it continues to do so.

Obstacle Limitation Surfaces

[24] The CARS recommends and/or regulates limits on the types of obstacles that may be placed on "surfaces" (ground or water) in the vicinity of an aerodrome. In Part I, Subpart 1, it defines an obstacle limitation surface as follows:

> ***obstacle limitation surface*** means a surface that establishes the limit to which objects may project into an aerodrome's airspace, so that aircraft operations for which the aerodrome is intended may be conducted safely, and consists of a transitional surface, a take-off surface, an approach surface and an outer surface;

The CARS contemplates the designation of obstacle limitation surfaces for airports, with the specific parameters outlined in TP312. However, with respect to uncertified aerodromes (aerodromes that are not airports), the CARS only references obstacle limitation surfaces for purposes of determining when lighting and marking requirements are required. Again, however, it must be noted that implementing TP312's requirements is considered a best practice to promote air navigation safety at all aerodromes, including uncertified ones.

Visual Flight Rules versus Instrument Flight Rules

[25] There are specific rules that pilots must adhere to when flying. These include Visual Flight Rules ("VFR"), which are generally used by recreational pilots, and Instrument Flight Rules ("IFR"), which are generally used by commercial and more advanced pilots. In his witness statement, Mr. Cormier described the difference between VFR and IFR as follows:

> Pilots may operate their aircraft under Visual Flight Rules (VFR) or Instrument Flight Rules. Most recreational pilots fly VFR only, which requires reasonable weather conditions, visual reference to the ground, and adherence to the principle of see-and-be-seen. VFR pilots must avoid clouds and maintain a safe height above ground unless taking off or landing. IFR pilots require more training, must pass an annual test, and have more instruments and navigational aids in their aircraft. They can fly on their instruments in almost any weather, do not need reference to ground, and require a clearance from the air traffic control agency.
>
> Take-off (departure) and landing (approach) can occur under VFR, or by IFR using a published instrument procedure, as follows:
>
> Visual departure/approach: the pilot departs/approaches by visual reference alone in conditions where the pilot's field of vision is not obstructed by clouds or other inclement weather. Pilots who take-off and land visually are not required to have an instrument rating.
>
> Instrument departure/approach procedure: this is an airport or aerodrome procedure, approved by NAV CANADA used in inclement weather to support visual take-off or landing. Instrument approaches allow a pilot to use aircraft instrumentation to guide the aircraft through non-visual means to a position from which the aircraft can either be visually landed safely or a missed approach performed if the pilot cannot see the runway adequately to execute a normal landing.
>
> An instrument approach or departure procedure cannot be used by a pilot who does not have an instrument rating. In addition, many aerodromes do not have approved instrument procedures, meaning take-off and landing may only be accomplished visually.

[26] Part 704.23 of the CARS sets the mandatory obstacle clearance requirements for VFR flight. It states:

> Except when conducting a take-off or landing, no person shall operate an aircraft in VFR flight
>
> (a) at night, at less than 1,000 feet above the highest obstacle located within a horizontal distance of three miles from the route to be flown; or
>
> (b) where the aircraft is an aeroplane, during the day, at less than 500 feet AGL [above ground level] or at a horizontal distance of less than 500 feet from any obstacle.

[27] Part 602.115 of the CARS sets the minimum visual meteorological conditions for VFR flight in uncontrolled airspace. It states:

> 602.115 No person shall operate an aircraft in VFR flight within uncontrolled airspace unless
>
> (a) the aircraft is operated with visual reference to the surface;
>
> (b) where the aircraft is operated at or above 1,000 feet AGL
>
> (i) during the day, flight visibility is not less than one mile,
> (ii) during the night, flight visibility is not less than three miles, and
> (iii) in either case, the distance of the aircraft from cloud is not less than 500 feet vertically and 2,000 feet horizontally;
>
> (c) where the aircraft is not a helicopter and is operated at less than 1,000 feet AGL
>
> (i) during the day, flight visibility is not less than two miles, except if otherwise authorized in an air operator certificate,
> (ii) during the night, flight visibility is not less than three miles, and
> (iii) in either case, the aircraft is operated clear of cloud;
>
> …

[28] Consequently, pilots flying under VFR must not only maintain visual contact with other planes flying at the same altitude, but also with planes or other obstacles below and above them.

Aerodynamics of Flight

[29] A plane's forward velocity is provided by either motor-driven propellers, typically employed by smaller aircraft, or by jet engines, usually in larger aircraft. This forward velocity creates movement of air over the front of the plane's wings, which, in turn, creates the air pressure dynamic which lifts the plane into the air. Standard flight practice recommends that planes take off into the wind, i.e. travel in the opposite direction that the wind is blowing (also described as a headwind). The headwind blowing over the wings creates additional lift. This means that, in order to achieve the lift necessary to become airborne, a plane travelling into the headwind can travel at a lower ground velocity, which, in turn, requires a shorter takeoff run for the plane to become airborne.

[30] It is trite to observe that, unlike automobiles, there is no reverse gear in a plane. In order for a plane to take-off and remain aloft, the plane must achieve and maintain a minimum forward velocity. The air must flow evenly over the wings to maintain lift. However, the angle in which a plane travels through the air can reach a critical point, where, aerodynamically, the wings no longer provide sufficient lift, resulting in aerodynamic stall, where a pilot would lose control of the plane and it would begin to fall. A pilot may be able to maneuver the plane to re-establish control of the plane if an aerodynamic stall occurs. It must be noted that aerodynamic stall is different from engine stall. In the case of an engine stall, the plane can continue to glide, and, hopefully, a pilot would be able to maneuver the plane in order to land safely.

[31] It is also trite to observe that, unlike an automobile, a plane in mid-air cannot slow down to a stop in order to make a 90 degree turn. A safe turn, known as a standard rate turn, would, at approach velocity, require a bank angle of approximately 15 degrees, and take 60 seconds to complete 180 degrees (30 seconds for 90 degrees, 15 seconds for 45 degrees and so forth). A steeper bank angle will effect a faster turn, but if the angle is too steep the aircraft may aerodynamically stall, which would cause the pilot to lose control of the plane, at the very least, temporarily. The plane would also begin to lose altitude. If the pilot could not maneuver the plane out of the stall, the plane

would impact with the ground. It is also important to remember that a plane maintains forward velocity during the time required to complete a turn, so, during a turn, a plane continues to travel a horizontal distance as measured in relation to the ground.

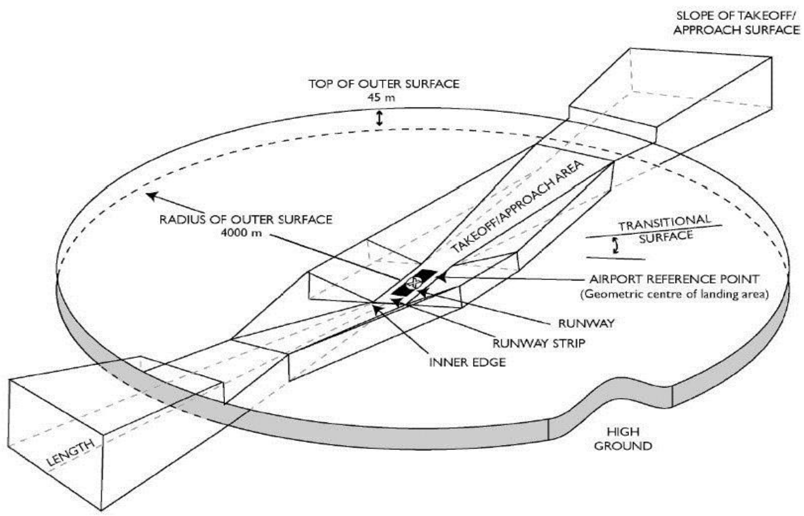
[32] The velocity at which a plane must fly in order to maintain lift, depends on the size and type of plane. In the air industry, a plane is described as falling within one of four categories (A through D) based on the range of velocity at which it can travel. Smaller planes, which include those generally used for recreational purposes, are grouped in either Category A or B, and the largest planes, such as passenger jets, are grouped in Category D.

[33] The evidence in this proceeding respecting velocity (i.e. distance travelled over time) measured it as either miles per hour, feet per second, kilometres per hour, metres per second, or knots (one nautical mile (1.852 km or 1.151 miles) per hour). The evidence regarding the highest velocity capacity for each category of plane was expressed in knots. For the purpose of this Order, the Tribunal has converted knots into both kilometres per hour and metres per second. One knot is equal to 0.514 metres per second. The highest velocity capacity for each plane category is set out in the following table:

CATEGORY	KNOTS	KILOMETRES PER HOUR	METRES PER SECOND
A	90	166.68	46.30
B	120	222.23	61.73
C	140	259.27	72.02
D	165	305.57	84.88

Runways and Circuit Patterns: Takeoff and Landing

[34] Although obvious, it is important to emphasize that planes travel in 3-dimensional space. As previously noted, under the CARS, the obstacle limitation surface consists of a transitional surface, a take-off surface, and an approach surface. The Takeoff/Approach Surface zones, indicate the range of 3-dimensional space in which a plane would be expected to be located when taking off or landing. These zones are depicted in the following diagram.

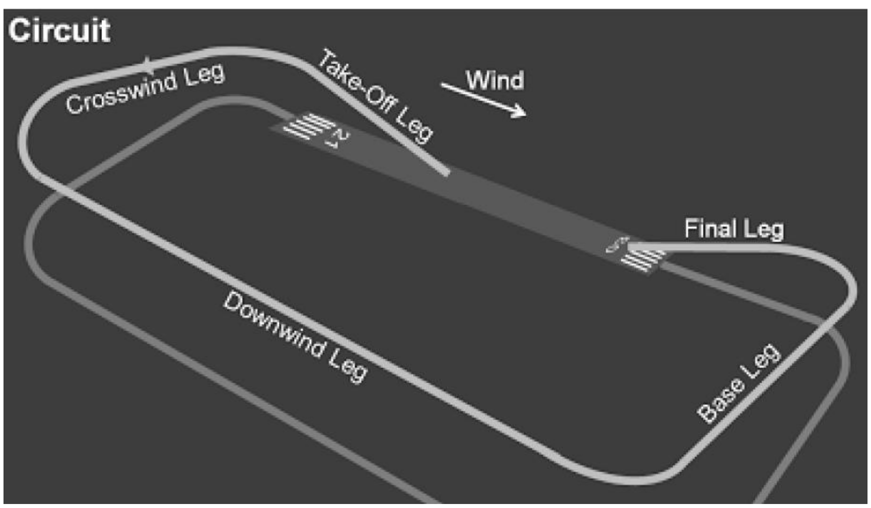


It should be noted that this zone is wider than the actual runway. Transport Canada has indicated that, although an aerodrome, which is not an airport, does not have to comply with the obstacle limitation surfaces identified in TP312, the operational integrity is enhanced if the designation of the use of land adjacent to the aerodrome is done in line with the technical portions of the standards. For pilots flying under IFR, an aerodrome operator is required to prepare an instrument flight plan which provides pilots with precise instructions for landing or takeoff. Such plans must be submitted to and approved by NAV CANADA before they can be published for use by pilots.

[35] Planes travel either direction on a runway depending on the wind direction. Under Part 602.96 (e) of the CARS, planes are required, where practicable, to land and take off into the wind unless otherwise authorized by the appropriate air traffic control

unit. So, on any given day, the prevailing winds will determine which direction on the runway a plane will travel. In order to identify runway directions, it is protocol to give a runway two identification numbers. For example, at CRA, one end of the paved runway is assigned the number 13, and the other end is 31. At Clearview, the runway numbers are 16 and 34. There is a standardized method for determining the numbers for any runway based on the direction of the runway in relation to compass direction of true North.

[36] It is obvious that there are no marked flight pathways in the sky. In uncontrolled airspace where there is no air traffic controller to direct traffic, planes are required to follow a circuit pattern when leaving or approaching a runway, in order to avoid collisions. The circuit is best described using the following diagram:



This circuit pattern diagram shows the path for takeoff and landing. If a pilot's destination lies in the same direction as the Take-Off Leg, the pilot is not required to complete the turn to the Crosswind Leg, but, instead, may continue in the same direction, provided there are no other planes or obstacles present in his/her path. Otherwise, the pilot is required to turn, traverse the Crosswind Leg, and then turn again onto the Downwind Leg. The pilot may then leave the Downwind Leg in the direction of his/her destination. Pilots who wish to land on the runway will generally navigate their planes to join the circuit on the Downwind Leg, turn to traverse the Base Leg, and then turn again onto the Final Leg, where the plane will make its final descent onto the runway.

[37] In terms of altitude, a plane that is taking off from the runway is expected to climb to an altitude of 500 feet above the ground by the time it turns onto the Crosswind Leg, and to climb to 1,000 feet by the time it turns onto the Downwind Leg. A plane that is landing joins the Downwind Leg at 1,000 feet above ground. Once it turns onto the Base Leg, the plane is expected to descend to 500 feet, before turning onto the Final Leg to approach and land on the runway. However, it must be remembered that pilots flying under VFR rules are required to fly below the cloud ceiling in order to comply with the requirement that they maintain visual contact with the runway. Consequently, where the cloud ceiling is low, a pilot may be required to fly at less than 1000 feet above ground.

[38] It is important to note that, although the circuit diagram depicts a precise “centre line” that a pilot will follow, in practice, planes only travel on or near this notional line. A circuit pattern, therefore, is better described as prescribing a pathway, not a precise line and altitude, where planes are expected to fly when taking off or landing. As stated in Mr. Hatcher’s witness statement:

> There is no precise place in the sky where the location circuit is located, nor are there any markings on the ground to designate this, nor is there any instrument in the aircraft which indicates the aircraft is or is not positioned correctly within the circuit. The downwind, for example, is more properly thought of as a corridor, rather than a line. It is based upon visual reference relative to an active runway, as modified by the performance of the aircraft, and the position and relative performance of other aircraft in the circuit as well as prevailing weather conditions such as wind speed and direction and meteorological conditions affecting visibility. The circuit pattern has been designed so that pilots flying in the circuit should be able to see each other and the runway at all times.
> …
>
> Further, the circuit is intended to be at such a distance from the runway so as to allow an aircraft entering the circuit, from any point, to be able to reach the runway directly while gliding in the event of an engine failure during this phase of the flight (while obviously announcing this intention to other aircraft in the circuit). If the circuit is crowded, for example, then the pilot may elect to “extend the downwind” so as to ensure there is a comfortable margin of separation between their aircraft and the one in front of them to allow the latter aircraft sufficient room and time to land

> and clear the runway before the subject aircraft turns onto the final leg to land. This can also occur if there are aircraft with differing speeds in the circuit. Any and all such adjustments must be made on the spot, while maintaining visual contact with the other aircraft in the circuit, ensuring the aircraft is properly configured for such low speed and low altitude flight, paying particular attention to airspeed to avoid a stall and maintaining circuit height, with appropriate radio calls on the common frequency, all adding to the workload of the pilot.

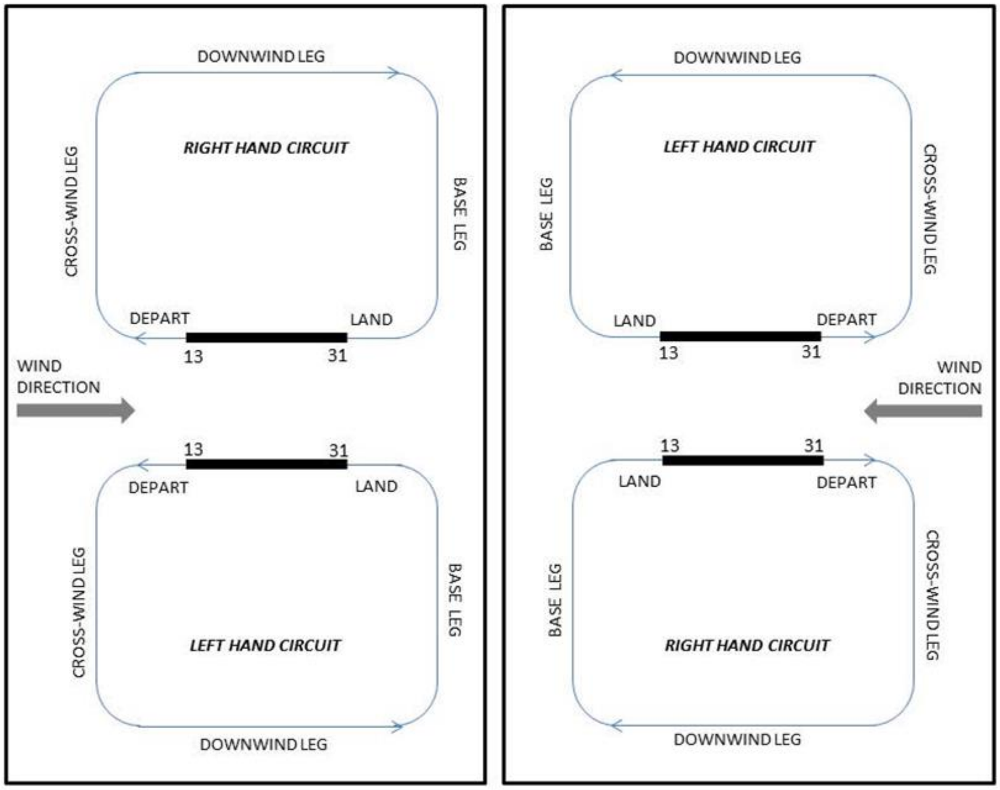
As stated in Mr. McKechnie's witness statement:

> Just how much an aircraft under distress, or due to severe weather, will stray from the centreline depends almost entirely on the skill of the pilot. Commercial pilots practice engine failures on take-off and during go-arounds during almost every simulator session. While most pilots can stay within 10 degrees I have seen some ugly situations where pilots have drifted 30 degrees or more. Unlike commercial pilots, however, recreational pilots do not undergo that level of emergency training. Straying from the centre line is more common for recreational pilots, and the distance they stray will be exacerbated by weather, turbulence, and even cockpit distraction.

Circuit Patterns: Left- and Right-Handed Circuits

[39] The circuit depicted in the above diagram is described as left-hand circuit pattern, because all turns made to complete the circuit are left-hand turns. A right-hand circuit pattern is also possible, where all turns made to complete the circuit are right-hand turns.

[40] The evidence adduced in this proceeding, includes maps showing the layout of some of the left- or right-hand circuits (in relation to the ground) depending on the direction that planes are travelling on the runway. However, not all the permutations were shown. To best describe the layout, the Tribunal has prepared the following visual diagram using CRA's runway numbers as an example:



[41] As the above diagram demonstrates, a left-hand circuit pattern will situate the circuit path to one side of the runway or the other, depending on the direction that a plane travels on the runway. The same observation applies if a right-hand circuit pattern is used.

[42] Several of the proposed wind turbines are located south of the CRA's paved runway in close proximity to the circuit path (right- or left-handed). The proposed locations of the wind turbines are described in greater detail below. Consequently, it is of considerable importance to note that, irrespective of whether a left- or right-hand circuit pattern is adopted, planes would be required to fly the circuit pattern to the south of CRA's main runway. The only way to avoid this situation would be for CRA to require pilots to fly a right-hand circuit pattern when travelling Runway ("RN") 31/13, and a left-hand circuit pattern when travelling RN13/31.

[43] Part 602.96 of the CARS, sets requirements for planes operating at or in the vicinity of an aerodrome:

> 602.96 (1) This section applies to persons operating VFR or IFR aircraft at or in the vicinity of an uncontrolled or controlled aerodrome.
>
> (2) Before taking off from, landing at or otherwise operating an aircraft at an aerodrome, the pilot-in-command of the aircraft shall be satisfied that
>
> (a) there is no likelihood of collision with another aircraft or a vehicle; and
>
> (b) the aerodrome is suitable for the intended operation.
>
> (3) The pilot-in-command of an aircraft operating at or in the vicinity of an aerodrome shall
>
> (a) observe aerodrome traffic for the purpose of avoiding a collision;
>
> (b) conform to or avoid the pattern of traffic formed by other aircraft in operation;
>
> (c) make all turns to the left when operating within the aerodrome traffic circuit, except where right turns are specified by the Minister in the *Canada Flight Supplement* or where otherwise authorized by the appropriate air traffic control unit;
>
> (d) where the aerodrome is an airport, comply with any airport operating restrictions specified by the Minister in the *Canada Flight Supplement*;
>
> (e) where practicable, land and take off into the wind unless otherwise authorized by the appropriate air traffic control unit;
>
> (f) maintain a continuous listening watch on the appropriate frequency for aerodrome control communications or, if this is not possible and an air traffic control unit is in operation at the aerodrome, keep a watch for such instructions as may be issued by visual means by the air traffic control unit; and
>
> (g) where the aerodrome is a controlled aerodrome, obtain from the appropriate air traffic control unit, either by radio communication or by visual signal, clearance to taxi, take off from or land at the aerodrome.

In applying this Part to CRA and Clearview, it is necessary to reiterate that neither of them are airports nor do either of them have an air traffic control unit. Regarding taking off or landing, the CARS Part 602.96 (3) (e) mandates that the circuit pattern to be flown is a left-hand circuit pattern, unless a right-hand circuit is approved by the federal

Minister of Transportation. In Canada, approximately 3 to 4 per cent of aerodromes have received approval for a right-hand circuit. Where a right-hand circuit applies, it is a pilot's responsibility to be familiar with this and other flight information as required under Part 607.71 of the CARS.

[44] There are safety reasons why the standard circuit is flown with left-hand turns. By convention and design, the pilot in command of an aircraft typically sits in the left seat of the aircraft, and, therefore, has a less obstructed view from the left side window. As stated in Mr. Hatcher's witness statement:

> Thus, if the pilot in command is in the left side of the aircraft, he or she will have the best view of the position of the aircraft relative the runway (upon which the circuit is based) as well as the best view to ensure there are no other aircraft in the area into which the aircraft is about to turn. The better view of the runway out the left side also allows the pilot to more easily fly a straight and properly positioned circuit, ensure that no other aircraft, personnel, equipment or wildlife have entered onto the runway and also allows the pilot to more accurately judge a turn to the base leg which is important to properly set up the final leg and thus, the rate of descent for the final leg as well as being able to quickly spot the runway for an emergency descent in the event of an engine failure so close to the ground.

[45] A pilot sitting in the left seat of the plane and looking out the left window also has a better view of objects in the sky above and below the plane. However, as Mr. Hatcher points out, a right-hand circuit is not unsafe *per se*. As he stated in his witness statement, it is simply less safe than a left-hand circuit, because the pilot may have partially obstructed views when looking out the windows of the aircraft.

[46] Witnesses for the Appellants also emphasized that right-hand circuits are rare, so they caution against introducing a right-hand circuit at either CRA or Clearview. They acknowledge that pilots, in advance of their departure, are required to familiarize themselves with the landing protocol of their destination airports. However, they caution that, due to human error, some pilots may not do so, simply assuming that a standard left-hand circuit applies. It is not disputed that, if a pilot erroneously adopted a left-hand circuit approach where a right-hand is required, such a situation would create the potential for a mid-air collision.

[47] Mr. McDonald, who testified for the Approval Holder, emphasizes that, under VFR, it is the responsibility of the pilot to avoid obstacles and fly the plane in accordance with an aerodrome's designated circuit pattern. He points out that, in the Royal Canadian Air Force, student pilots are taught how to fly right-hand circuits, and such circuits are flown about 50 per cent of the time. He also points to other airports that use both left- and right-hand circuits on their runways. As is discussed in greater detail below, Mr. McDonald suggests that a right-hand circuit could be implemented at both the CRA and Clearview, if required, in order to mitigate any obstacle safety concerns posed by the proposed Project's wind turbines.

[48] In a letter dated November 17, 2014, a Transport Canada representative, replied to earlier correspondence from the MOECC requesting information in respect of the Project (the "Transport Canada Letter"). In this letter, Transport Canada notes that a right-hand circuit is one of the ways to mitigate the impact of obstacles that lie within the circuit pattern for both CRA and Clearview, noting that an aerodrome operator could request Transport Canada to approve a right-hand circuit for these runways. However, in this letter, Transport Canada does not indicate its approval of a right-hand circuit for either of these runways. No other evidence was adduced in these proceedings to indicate that a right-hand circuit would be approved by the Minister of Transportation, as required under Part 602.96 of the CARS.

Altimeters

[49] Nearly all aircraft have an altimeter which measures the altitude of the aircraft. As noted by Mr. Hatcher, the standard altimeter does not and cannot directly measure the distance between the aircraft and the ground. Rather, the altimeter measures the air pressure outside the aircraft and converts this to a measure of altitude. In his witness statement, he explains:

> As the aircraft and altimeter rise in altitude, the outside air pressure decreases at a predictable rate, roughly equal to one inch of mercury pressure decrease corresponding to approximately 1000 feet of altitude. The altimeter is calibrated such that as pressure decreases, it records that decrease in air pressure as an increase in aircraft altitude. Similarly,

> when the aircraft descends, the outside air pressure increases, which the altimeter detects and displays, not as an increase in air pressure, but a decrease in aircraft altitude.

Mr. Hatcher further explained that changes in ambient air pressure due to local meteorological conditions will be sensed by an altimeter, with the result that an altimeter may report an incorrect altitude. Pilots who obtain the information regarding such conditions, can manually adjust their altimeters to give a correct altitude reading. However, Mr. Hatcher points out that the potential for inaccuracy remains. He first notes that there may be localized air pressure changes of which the pilot is unaware, that results in an inaccurate altimeter reading. The pilot, in response to the inaccurate altitude reading, may then change the plane's altitude on the erroneous assumption that the plane is not flying at its intended altitude. Mr. Hatcher emphasized:

> … small variances between the proper altimeter setting at the destination aerodrome and the last altimeter setting available to the pilot en route become important when descending to land. This is especially true when operating in conditions of reduced visibility and/or at night.

[50] Mr. Hatcher also explained that altimeters have a margin of error based on two variables that commonly occur. First, for VFR, Mr. Hatcher explained that an altimeter is not considered to be defective until an altimeter error exceeds 200 feet. Secondly, pilots do not always fly at the required altitude as they attend to navigating a plane. Mr. Hatcher notes that, on a private pilot's exam, a pilot is allowed to deviate plus or minus 100 feet from a given altitude, and still be considered to have passed the skill demonstration.

Wind Turbulence

[51] Wind turbines create wind turbulence in their wake. As ambient wind flows over and through the rotating blade, wind velocity immediately downstream of a wind turbine is reduced, typically by 50%. The blades also create swirling pockets of air described as vortices. This wake turbulence gradually abates as it travels further from the blades. Eventually, the turbulence subsides, returning to ambient wind conditions. There is agreement among the experts that turbulence that occurs very close to wind turbine

blades will impair a pilot's ability to safely fly an airplane. In their reply witness statement Messrs. Moore and Dershowitz state:

> Rather than turbulence intensity, the greatest hazard to aircraft is the changes to the mean flow in the wake itself. The wind turbine creates both a change in the axial windspeed and would be expected to impart some rotational velocity to the flow due to the drag of the blades. … An aircraft flying more parallel to the wake would encounter a wind shear and a rotation due to the swirl in the wake.

In their witness statement, Messrs. Duncan and Hutton point out that light aircraft …

> …do not have the mass nor energy to easily penetrate rough air or turbulence. In flight at higher speed and altitude this risk can be more safely mitigated, but near the ground in landing and take-off phases these risks are not easily mitigated.

[52] There is disagreement among the experts as to the distance from the wind turbine where turbulence generated by the wind turbine blades no longer poses a navigational hazard for a pilot. Some maintain that the distance is ten rotor diameters or more. However, there is, at least, agreement that wind turbulence is a concern at a distance up to five rotor diameters (462.5 metres) from the turbine blades.

Meteorological Conditions

[53] The CRA and nearby Clearview are located close to the shores of Georgian Bay, which impacts local weather conditions. Mr. Mawson, a climatologist, provided evidence regarding common weather conditions in this region for winter and summer.

[54] Regarding winter weather, Mr. Mawson noted that the CRA is highly susceptible to unanticipated and sudden lake-effect snow storms on a small and/or large scale, and short and/or long in duration. These are intense snow squalls, which can vary in their intensity and their duration. They are caused by the interaction of cold arctic air with a warmer body of water, in this case, Georgian Bay. Such storms are not unusual in southern Ontario. Climatologists can forecast the counties where such lake-effect snow storms may occur, but determining their exact location is almost impossible. Such storms are described as ribbon-likes streamers: they are narrow and tend to meander

length-wise. Consequently, automobile drivers or pilots can encounter a dangerous snow squall, only to find that the weather may suddenly clear. This is particularly true when the driver or pilot traverses a snow squall perpendicular to the length of the streamer. Radar can identify such streamers once they are formed, but cannot be used to predict when they will specifically occur, or where they may meander once formed. Snow squalls can develop quickly if wind speeds and/or directions increase or change unexpectedly. This is especially common in areas such as the southern Georgian Bay region as a result of the proximity to the Bay.

[55] Another winter condition mentioned by Mr. Mawson is freezing rain. Annually, Collingwood receives approximately 14 hours of freezing rain over five freezing rain days. Freezing rain is a challenging meteorological phenomenon to forecast. Often freezing rain may form in a narrow band between an area of snow and rain. The extent of the freezing rain may not be well delineated. In some cases, it may not develop at all, and in other cases it may catch forecasters and pilots by surprise. Freezing rain can create ice on a plane's wings, altering the aerodynamic performance of the plane, resulting in the plane's speed and thrust decreasing, while weight and drag increases. Pilots faced with aircraft icing as a result of freezing rain are required to make decisions quickly to avoid a build-up of ice on the wings, tail and fuselage. In order to dissipate icing, pilots are often required to change altitude up or down to find warmer temperatures.

[56] Regarding summer weather, Mr. Mawson referred to pulse thunderstorms triggered by lake breezes, noting that Collingwood receives approximately 28 thunderstorm days per year. He explained that pulse thunderstorms form randomly, are rarely severe and are highly unpredictable. The features of this type of thunderstorm includes heavy rain, strong downburst winds, small hail and tornadoes. Downburst winds are a concern as they can force a plane to quickly lose altitude.

[57] In planning their flights, pilots are expected to familiarize themselves with the weather conditions they will encounter. Part 602.72 of the CARS states:

> 602.72 The pilot-in-command of an aircraft shall, before commencing a flight, be familiar with the available weather information that is appropriate to the intended flight.

Human Factors - Pilot Error

[58] Pilot behaviour is an important consideration to take into account when addressing safety at an aerodrome. Human factors that may affect a pilot's decision-making while inflight are critical. These include the pilot's workload when in-flight, biases, and mental, emotional or physical state. Mr. Cormier noted that pilot error is normal and any pilot may make numerous errors on any one flight.

[59] Citing data compiled by NASA, Messrs. Duncan and Hutton stated that high workload is a contributing factor in 80% of aviation accidents. They testified that workload increases in proportion to distraction and a pilot's competence and training and that increasing the challenges placed before a pilot escalates the potential for an accident. Mr. Hatcher testified that the approach, circuit and landing phases are the highest workload phases of a flight. He stated that during these phases, a plane is most vulnerable as it is at its lowest energy state and is low to the ground, making recovery from unexpected events often challenging.

[60] The skill and experience of the pilot are important considerations. Mr. Gascoine stated that itinerant pilots, inexperienced pilots, and pilots who are unfamiliar with the CRA often fail to follow standard procedures when approaching, circuiting or landing at the aerodrome. He stated they at times fly in on the wrong radio frequency, join the circuit incorrectly and/or fly using outdated information.

[61] Mr. McKechnie stated that the cumulative effect of multiple hazards and threats, including bad weather, turbulence, obstacles, mechanical issues, fuel concerns, medical issues and others can overwhelm a pilot leading him or her to make poor decisions. Mr. Duncan added that fear that may occur when a pilot is startled by an unexpected event can cause him or her to become overwhelmed.

[62] Mr. McKechnie described pilot biases that may lead to poor in-flight decision-making by pilots. He stated that pilots are often prone to be reluctant to change their flight plans when they encounter unsafe conditions in order to maintain the respect of other pilots, their passengers or their employers. He said that biases such as this create a false sense of security that may lead to unsafe aviation practices.

[63] The mental, emotional or physical state of the pilot can also be factors leading to poor in-flight decision-making. Mr. Duncan stated that fatigue, fear and other factors can cause a pilot to become overwhelmed quickly.

[64] Mr. McKechnie concluded that development around aerodromes must not be planned around pilots making perfect decisions. He stated:

> ... there's a substantial risk and I think it's an unacceptable risk by putting those wind turbines in exactly where they are. I think that's the worst possible position that they could be in with respect to the Collingwood Airport. You're asking pilots to be perfect, and as Mr. Gascoine said today, pilots are not perfect. And I know I'm not perfect. I've made all the mistakes and I'm going to make a heck of a lot more mistakes in my career. So pilots are definitely not perfect. By putting those wind turbines there, you're asking them to be pretty darn close to being perfect, and I just think that's it an unacceptable risk, it's a significant risk.

Activity Profile of the CRA

[65] The CRA has a 5,000 foot long paved runway, oriented north-west by south-east. RN 13/31 indicates the direction of the runway pointing eastward, while RN 31/13 indicates the direction pointing westward. CRA also has a 2,450 foot unpaved runway oriented north/south which is infrequently used. In addition to the runways, CRA also has a dedicated terminal building and a range of ancillary facilities including 38 private aircraft hangars. It is capable of accommodating various types of corporate jet aircraft as well as many smaller general aviation aircraft.

[66] As previously noted, the airspace at CRA is uncontrolled. There is no air-traffic control tower where controllers guide pilots into the appropriate landing-approach position, nor is there is anyone to remind pilots of obstructions. Pilots navigate in

accordance with the requirements set out in the CARS, utilizing best practices and their training.

[67] The CRA is one of the busiest municipal/general aviation airports in Southern Ontario. As of 2011, the CRA recorded approximately 12,000 “movements” per year during business hours, i.e. either a take-off or a landing. Mr. Lajoie, the CRA manager, estimates that there were an additional 1,200 movements occurring outside of business hours. He also noted that the number of movements continues to increase, year by year, making the uncertified CRA busier than many certified airports.

[68] The types of pilots using the CRA are comprised of individuals from a range of backgrounds: private recreational, corporate, military, Med Evac, Ontario Provincial Police, Ministry of Natural Resources and Forestry, Ontario Hydro, Royal Canadian Mounted Police (RCMP), Coast Guard, and staff and students involved in flight training from the two flight schools located at the CRA.

[69] The CRA is also a popular location for flight training by flight schools based in other airports in Southern Ontario located within 30 minutes flying time. The CRA receives almost daily flights from these schools. Cross-country flights are mandatory for pilot license training, and many aircraft arriving at CRA are solo flights, without an instructor.

[70] There are approximately 95 aircraft based at the CRA full time. Only 30% of movements are local (i.e. a plane departs from and returns to the CRA). Approximately 70% of the movements at CRA are conducted by planes arriving from or departing to other aerodromes or airports located anywhere in Canada, the United States, or Bermuda.

[71] In 2014, 90 per cent of the takeoffs and landings were conducted by aircraft weighing 2,000 kilograms or less, which typically fall in Categories A or B in terms of speed, and close to 30 per cent of this activity is conducted by flight training students.

[72] The vast majority of takeoffs and landings (approximately 90 per cent) are conducted under VFR. Most of the pilots that land at CRA are recreational pilots, travelling from other regional airports either for tourism purposes, commuting between urban centres, or logging training or certification hours. These pilots generally do not have sophisticated Global Positioning Systems (“GPS”) in their planes, nor do they generally have early warning/collision avoidance technology. Some do not have even communication radios on board.

[73] The remaining 10 per cent of takeoff and landings are flights conducted under IFR. IFR is utilized by some recreational pilots and pilots flying corporate and charter jets. IFR is also utilized by Emergency Medical Services and military (Department of National Defence) Med Evac jets that are returning sick tourists, and military Search and Rescue.

Activity Profile of Clearview

[74] Clearview was registered with Transport Canada in 2011 as an aerodrome. It is located a few kilometres south of the CRA. It has one 1,953 foot grass runway located on land privately owned by Mr. Elwood, who is one of the Appellants in this proceeding. As previously noted, airspace at Clearview is uncontrolled. As a registered aerodrome, the Clearview runway is open to the public. Mr. Elwood estimates that, on average, there are 400 takeoffs and 400 landings per year at the strip. It is used year-round as a destination and a departure point for local pilots and for Mr. Elwood and his sons. When there is snow, the runway is principally used for flight training on skis.

[75] Mr. Elwood’s witness statement indicates that:

> Clearview Field provides an operating environment where new pilots can develop sound pilot making decision [sic] skills as the aerodrome requires consideration of all operating conditions to ensure a safe completion of each flight. This is important when a pilot transitions into piloting aircraft unsupervised or in an off airport environment such as float flying and bush flying. Local flight instructors in the area use Clearview Field as a training environment for emergencies and short field decision making.

Communication Services Provided by the CRA and Clearview

[76] As previously noted, the CRA and Clearview are uncontrolled airspaces, which means that they do not provide communications from an air traffic control tower or control unit. Under the federal aviation regime, certain geographic areas have a mandatory radio frequency service which could provide radio-equipped aircraft with some information to assist an approaching pilot, either directly on the field or remotely from a monitoring location. However, neither the CRA nor Clearview are located in one of these areas.

[77] The CRA has does have a radio transmission service that broadcasts on a specified universal communication frequency (described as a “Unicom”). If they have a radio, all pilots within five nautical miles and flying at 3,700 feet above sea level or below are expected to tune into this Unicom frequency to broadcast their intentions to other aircraft in the area and to monitor the broadcasts of other aircraft in the area. The Unicom is at times monitored from the ground by CRA staff who may, if present, respond to an approaching pilot who requests information. Typical information provided to an approaching aircraft on a Unicom includes identification of the active runway and wind strength and speed, if that information is available. However, there is no requirement that the Unicom actually be operated by anyone at the CRA, and no requirement that someone operating the Unicom have proper training to provide information.

[78] Although the CRA reports weather information for pilots, it is not recorded. CRA’s Limited Weather Observation System reports temperature, dew point, wind speed and direction, visibility and local air pressure conditions so pilots can manually adjust their altimeters. The CRA does not provide reports on snow conditions and cloud coverage, and CRA staff are not qualified to give verbal weather information. The CRA neither measures nor reports on the altitude of the cloud ceiling, as it does not have the radar equipment to do so. The CRA also does not provide information on runway conditions. Environment Canada maintains weather stations that report on conditions over the past 24 hours, including the following specific data: cloud conditions, temperature, wind

velocity and direction, Humidex, relative humidity, dew point, atmospheric pressure, and visibility. This data is published on the Internet and is accessible by the public. As Environment Canada does not operate a weather station at Collingwood, pilots must refer to the nearest weather stations located at Canadian Forces Base Borden, Wiarton, or Muskoka. The Appellants state however that local weather conditions at these stations often differ from those at Collingwood.

[79] As a small aerodrome, Clearview does not provide any weather reporting services. Pilots using the Clearview runway may communicate via the Unicom as described above. NAV CANADA's Canada Flight Supplement, which provides information on airports and registered aerodromes in Canada, identifies Mr. Elwood as the aerodrome operator, and provides his telephone contact information.

Flight Training in Canada

[80] Pilot licences are issued and regulated by Transport Canada. Flight training includes three main components: training where the student pilots a plane under the supervision of the flight trainer; classroom training, which may include computer flight simulator training; and a written examination and flight test. There are several types of licences, including: private, commercial, and recreational pilot licence. Most of the flight traffic at the CRA is conducted by pilots holding either a recreational pilot's licence or private pilot licence.

[81] To obtain a recreational pilot's licence, the student pilot is required to complete 25 hours of in-flight training, pass a written test (minimum 60%), and pass a flight test conducted by an approved Transport Canada examiner. A pilot holding a recreation pilot's licence is restricted to flying aircraft with four seats or less, and may carry only one passenger. The recreational pilot is permitted to fly under VFR, but not IFR.

[82] The requirements to obtain a private pilot licence are more rigourous. The student pilot must complete 45 hours of flight training, which must include three hours of cross-country flight, and five hours of flight under IFR. In this training, pilots gain

extensive experience in all aspects of aircraft handling, emergency procedures, radio procedures, navigation and basic instrument handling. The private student pilot must also complete 45 hours of classroom training, and then is tested by a Transport Canada examiner.

Profile of the Genesis Flight Training School

[83] The Genesis Flight Centre and Genesis Flight College, ("Genesis") is a flight training school located at the CRA. Genesis is certified by Transport Canada as a flight training unit to provide training for all aeroplane category licences and ratings, and is registered by the Ministry of Training, Colleges and Universities as a private career college. Genesis trains at least 30 pilots a year, flying 2,000 flight hours per year, and has plans for expansion. Genesis has trained a total of 152 pilots over the last four years for either a license or rating. At Genesis, the majority of pilots are trained in VFR. In terms of the benefits of the CRA location for Genesis, its manager, Mr. Gascoine explained:

> The CRA is a popular location for flight training by flight schools based in other airports in Southern Ontario. There are very few large obstacles compared to metropolitan areas like Toronto, Markham, etc. With fewer obstacles, the stress associated with learning to take-off, learning to land, or practicing a missed approach is lessened. At approximately 30 minutes flying time from the Toronto area, the CRA is a good travelling distance from other Regional Airports for training flights, and we receive a large number of training pilots from across the region during mandatory cross country training flights. The CRA is also a tourist destination airport for many licensed pilots from as far away as Ottawa and Sarnia.

Description of the Height of the Proposed Wind Turbine and their Proposed Locations Relative to the CRA and Clearview Runways

[84] The Project Description Report for the Project, introduced into evidence by Dr. Cox, indicates that the hub height of each wind turbine is 100 metres, and the blade length is 45.2 metres (148.29 feet), which means the wind turbine will be 145.2 metres (476 feet) tall as measured to the highest point reached by the tips of the turbine's

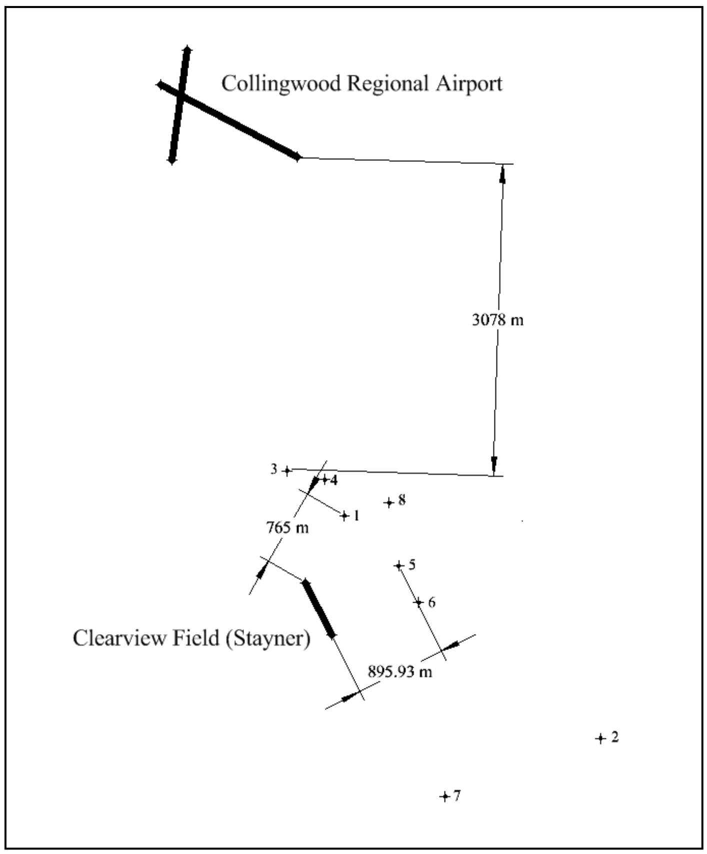
rotating blades. The rotor diameter is 92.5 metres (303 feet). Therefore, five rotor diameters is 462 metres (1,517 feet).

[85] The evidence adduced in this proceeding reports altitude in feet, so vertical height or altitude is measured in feet, while horizontal distances are measured in metres.

[86] The proposed locations of the Project's eight wind turbines in relation to the CRA and Clearview are best described visually. The Tribunal has used black and white copies of colour maps adduced into evidence. Attached to this Order as Appendix 2 is a map showing the proposed location of turbines 1, 3, 4, 5, 6, and 8 in relation to the CRA's main paved runway and the notional centreline of a standard left-hand circuit. Attached to this Order as Appendix 3, is a map of proposed location of turbines 1, 2, 3, 4, 5, 6 and 7 in relation to the Clearview runway and takeoff and landing zones. This particular map also depicts the five diameter turbulence zone around each turbine. Both of these maps confirm that the proposed locations of the wind turbines are in close proximity to the CRA and Clearview runways.

[87] For the purpose of this Order, it is useful to describe the distance, on the ground, between the wind turbines and the runways. Because planes are constantly moving forward at relatively high velocities, it is also useful to describe the amount of time that a plane will take in travelling over these ground distances. As previously noted, different categories of planes fly at different velocities. As the evidence indicates that the vast majority of takeoffs and landings at CRA and Clearview are by planes falling in Category A or B, the Tribunal has chosen the start of the velocity range for Category B (120 knots or 61.73 metres per second). This velocity is also the fastest speed for Category A, so 61.73 metres per second is fairly representative for the majority of air traffic at both the CRA and Clearview runways. However, it must be recognized that the time to cover the ground distance will be longer for planes travelling at less than 120 knots per hour, and shorter for planes that travel faster.

[88] As previously noted, circuit paths are notional path locations in the air, and their exact location is, to some degree, a matter of opinion. To provide a more concrete description of distance, it is helpful to identify the distance between fixed identified points on the ground, in this case, the end of the runway and the proposed location of the wind turbine. The following diagram taken from Dr. Cox's report visually provides this information:



[89] Using the distance legend on the map at Appendix 2 for the CRA runway, the shortest distance between wind turbines 1, 3, 4, and 8 and end of the runway (RN31) are in the range of 3,078 to approximately 4,000 metres. The time to travel 4,000 metres is 65 seconds. Wind turbine 5 is approximately 4,500 metres from the end of the runway, and wind turbine 6 is 5,000 metres away, so the respective travel times are 73 seconds and 81 seconds.

[90] Using the distance legend on the map at Appendix 3 for the Clearview runway, wind turbines 1, 3, 4, 5, 6, and 8 are all located within 1,500 metres from the end of the runway (RN16). The time to travel this distance is 24 seconds. Wind turbines 7 and 2 are, respectively, almost 2,000 and 3,000 metres from the other end of the runway (RN34). The travel times, respectively, are 32 and 49 seconds.

[91] The safety concern expressed by Mr. Elwood, and the other Appellants, relates to the proximity of all 8 wind turbines to the takeoff, transition and approach surfaces for the Clearview runway. Evidence provided by Messrs. Duncan and Hutton provides additional information regarding the distance between each of these wind turbines and the notional centre line of the approach surfaces at each end of Clearview runway. This centre line can be thought of as a notional line extending the runway from both ends. The following table provides the shortest distance between each wind turbine and the Clearview runway centre line, together with the amount of time, in seconds to travel this distance (fractional numbers are rounded upward), assuming a velocity of 61.73 metres per second.

TURBINE	DISTANCE TO CENTRE LINE (metres)	TRAVEL TIME (seconds)
1	631	10
2	1917	31
3	324	5
4	615	10
5	887	14
6	904	15
7	282	5
8	950	15

[92] As Appendix 3, and the above data indicate, wind turbines 1 and 3 through 8 are all in close proximity to the centre of the Clearview runway. In particular, wind turbines 3 and 7 fall within the 5 diameter hazard zone (462.5 metres) for wind turbulence.

Findings on Issue No. 1

The Position of the Responding Parties

[93] At the hearing, both the Approval Holder and the Director held the position that engaging in the Project in accordance with the REA will not cause serious harm to human health. However, in his final submissions, the Director qualified his position in light of evidence adduced at the hearing. Specifically, Dr. Cox, in cross-examination, agreed that there was an unacceptable safety risk with respect to wind turbines 3 and 7, as planes taking off or landing at the Clearview runway would be flying in the turbulence zone at a distance of just three rotor diameters of one or the other of these wind turbines. Consequently, the Director states:

> As it was the opinion of all expert witnesses, who opined on turbine wake, whether they were called for the appellants or the respondents, that there was an unacceptable safety risk where turbines are located within 5 rotor diameters from the centreline approach, the Director can no longer support the locations of turbines 3 and 7 as currently approved. The Director takes no position on whether this evidence meets the test for serious harm to human health.

The Legal Test

[94] The issue the Tribunal must address is whether the Appellants have, on a balance of probabilities, established that the Health Test has been met. It is not disputed that the harm, if it occurs, would be due to: (i) injuries sustained if a plane collides directly with a wind turbine; or (ii) a crash, resulting from collision with a wind turbine, or loss of navigational control due to the positioning of the turbines or due to wind turbulence produced by a wind turbine. There also is no dispute that the harm would likely be serious, in that it would likely result in serious physical injury or death. Therefore, the central issue in this proceeding is whether such harm will occur due to the proposed locations of the Project's eight wind turbines.

[95] As noted in *Pitt v. Director, Ministry of the Environment,* [2014] O.E.R.T.D. No. 29 ("*Pitt*"), the burden of proof to establish the "will cause" requirement of the Health Test,

is not lessened because of the severity of the harm that will occur. As noted in *Erickson v. Ontario (Director, Ministry of Environment)*, [2011] O.E.R.T.D. No. 29 ("*Erickson*"), in addressing causation, the Tribunal may consider the cumulative and synergistic effects of multiple direct and indirect impacts.

[96] The first step is to determine whether the Health Test has been met, when assessed in light of the current existing operations at CRA and Clearview. In previous renewable energy appeal decisions, the Tribunal's analysis has typically conjointly considered both the evidence respecting harm and the ameliorative impacts of proposed mitigation. However, based on the evidence and submissions of the parties in this proceeding, the Tribunal considers that its analysis will be clearer if the Tribunal first considers whether the Health Test has been met in the context of the current operations at CRA and Clearview. If the Tribunal finds that the Health Test has been met, the Tribunal will then consider the impact of the Approval Holder's proposed mitigation measures.

[97] Mitigation measures may be implemented at a project site on lands within the management and control of an approval holder. However, the Approval Holder's evidence respecting mitigation measures, other than implementing the lighting requirements set out in the CARS, relates solely to operational changes at CRA and Clearview, which are not within the Approval Holder's control.

[98] The Approval Holder cannot force CRA or Clearview to change their operations. However, the wording of the Health Test makes it clear that whether the Project will cause serious harm to human health is not limited to geographical or property boundaries. Therefore, in determining whether harm will occur, the Tribunal will consider whether operational mitigation measures implemented at the CRA or Clearview aerodromes would reduce the likelihood of harm, irrespective of whether CRA or Clearview would agree to implement such measures.

[99] However, the Tribunal must evaluate whether the proposed mitigation measures are both feasible and will reduce the likelihood of harm. The reason for this is obvious. Even where a proposed mitigation measure could in principle reduce the level harm or

the risk that such harm will occur, it will achieve neither if it is not implemented. Whether a mitigation measure is feasible must be determined on the facts of each individual case. For example, a mitigation measure that would require CRA or Clearview, or the pilots flying there, to operate in contravention of the CARS, which is federal law, cannot be implemented, and, therefore, is not feasible. As well, a mitigation measure that would require error-free piloting is unlikely to be implementable, and, therefore, is not feasible.

[100] In this proceeding, a great deal of evidence was adduced regarding the federal aviation regime, more specifically, the requirement to avoid obstacles within the zone described as the obstacle limitation surface. Although it is acknowledged that this requirement is mandatory only for airports, the Appellants emphasize that this requirement should, nevertheless, be considered by the Tribunal, as it represents safe practice and is recommended by Transport Canada to be applied to all aerodromes. While minimum safety measures have some relevance, it is, nonetheless, important to note that regulatory authorities, in this case Transport Canada and NAV CANADA, may suggest or impose higher restrictions, even where the risk of harm is low, because they consider it is prudent to do so as a safety measure.

[101] As noted in *Pitt*, at para. 231:

> … in this case, the Tribunal must make findings respecting the Health Test, which is very specific. It must be shown the serious harm will occur. Hence, the regulatory policies, in and of themselves, are not evidence that harm will occur, unless they are based on other supporting evidence which indicates that harm will occur. In such circumstances, it is the supporting evidence that would be probative, not the policy itself.

The Tribunal received no evidence to suggest that the requirements of the federal aviation regime meet the stringent standard set out in the Health Test. Consequently, while safety requirements in the federal aviation regime may be indicative that harm *may* occur, they are, in and of themselves, not conclusive that harm *will* occur.

[102] The Tribunal now turns to the Approval Holder's submission regarding Condition O1 of the REA, which provides that mitigation measures relating to safety at CRA and Clearview will be recommended. This Condition states:

> O1. The Company shall retain an independent aeronautical consultant who has not represented the Company and was not involved in any of the studies submitted as part of the Application. *The independent aeronautical consultant shall recommend mitigation measures that, given the presence of the Equipment included as part of this Approval, and the governing Canadian Aviation Regulations (CARs) and Standards, will enable Collingwood Regional Airport and Stayner (Clearview Field) Aerodrome to fulfill their duties related to safety* [emphasis added].

[103] The Approval Holder submits that the impact of wind turbulence would also be considered under this condition:

> Moreover, the impact of wake turbulence, if any, would necessarily be considered in connection with the development of mitigation measures under Condition O of the REA which measures, as discussed above, the Tribunal must take as given in the course of its analysis under s. 145.2.1 of the *EPA* with respect to engaging in the Project *in accordance with* the REA.

[104] The Tribunal accepts that engaging in the Project in accordance with the REA necessitates consideration of all the conditions of the REA. However, for the following reasons, the Tribunal does not accept the Approval Holder's submission that the Tribunal must "take as given" that effective and feasible mitigation measures will be developed. If the requirement to mitigate the impacts of wind turbulence is to be determined and addressed in accordance with Condition O1, this will only occur if and when the Director's decision to issue the REA is confirmed. Hence, the net effect of this interpretation is to preclude the Tribunal from considering the impacts of wind turbulence, or any other risk of harm, in the context of determining whether the Health Test has been met. The Tribunal's jurisdiction under s.145.2.1 of the *EPA* cannot be ousted in this manner.

[105] Furthermore, in order for the Tribunal to consider a proposed mitigation measure, it must be described with sufficient particulars, so that the Tribunal can adequately assess whether such a measure can reduce the level of harm or the risk that such harm will occur. A proposal that delegates development of precise mitigation measures to a

third party at some later date is clearly insufficient. Condition O1 may have some benefits in addressing aviation-related issues that arise in the future after completion of this proceeding, but it is not a sufficiently particularized measure that can assist the Tribunal when applying the Health Test in this appeal hearing.

Assessing Causation - Quantitative versus. Qualitative Assessment

[106] Once it is determined that certain events, if they occurred, would result in serious harm to human health, it then becomes necessary to determine whether such events will occur at some time during the 20-year lifetime of the Project. Regarding the scientific evidence, two main analytical approaches to the causation issue have emerged from previous renewable energy approval appeal decisions. They are described as a quantitative assessment and qualitative assessment.

[107] A quantitative assessment can generally be described as a statistical probability assessment of risk. This approach analyzes information and data on the frequency of an event in the past in order to establish the likelihood of the incidence of the event over time. If it is accepted that such past experience may reflect future experience, the probability of future events can then be predicted.

[108] A qualitative assessment is a subjective evaluation of risk based on personal, albeit professional, judgement. Such judgments include an evaluative analysis provided by qualified individuals based on their expertise, i.e. their training, education, and/or experience. However, it is important to note that such subjective evaluations must be supported by information and analysis. Persons possessing the requisite training, education, and experience have acquired knowledge and information over time which informs their conclusions.

[109] There are advantages and disadvantages to both approaches. Neither approach can predict with absolute certainty whether a future event will occur. In *Erickson* at para. 629, the Tribunal stated:

> The Tribunal is to determine whether specified harms will be caused according to the applicable legal standard, which is a balance of probabilities. That standard is not the exact same standard used by scientists, statisticians or medical experts. The Tribunal will take its direction on determining whether the Appellants have proven that harm will be caused according to the legal concepts of proof and causation. In doing so, it will assess the scientific evidence and consider which approaches to causation and proof were used in that evidence.

Therefore, the Tribunal will carefully consider the probity of the information and analysis provided in support of either assessment methodology.

[110] In this proceeding, the experts agree that it is not possible to do a quantitative risk analysis regarding the potential for serious harm to human health caused by the Project. As Dr. Cox indicated in his report, any attempt to quantify the incremental risk by theoretical modelling would be so dependent upon assumptions and the choice of scenarios that it would be of no assistance to the Tribunal. He explained in oral testimony:

> You would have to evaluate an astronomical number of scenarios to do it by the method of normal quantitative risk assessment. And one of the particular reasons why I say that in this case is we are dealing with pilot aircraft, so they're under human control, and they can react to situations and that's how they do, and that's a problem that doesn't relate itself to quantitative risk assessment very well.

[111] Dr. Cox, who was called by the Approval Holder, provided a qualitative risk analysis. The Approval Holder nonetheless, asserts that a quantitative probability assessment is necessary in order to determine whether the Health Test has been met. In this regard, the Approval Holder cites *Pitt*, at para. 235:

> … specific opinion regarding the probability that serious harm will occur (i.e., its likelihood) is often much more useful than a general opinion that serious harm will occur. Generally speaking, less weight is given to an expert opinion that fails to set out the specific pathways used in reaching a conclusion in terms of data, assumptions, and analysis.

The Tribunal notes, however, that this observation only refers to the requirement that an expert opinion should be supported by data, assumptions and analysis. The Tribunal did not indicate in *Pitt* that a quantitative analysis is necessary in order to determine whether the Health Test has been met, nor did the Tribunal state that a quantitative analysis should be preferred over a qualitative analysis. In *Pitt*, The Tribunal considered and weighed the evidence provided under both assessment methodologies. Furthermore, the validity of a qualitative analysis has been recognized by the Ontario Court of Appeal in *Ostrander Point GP Inc. v. Prince Edward County Field Naturalists*, [2015] O.J. No. 1988 ("*Ostrander*"). At para. 66, Juriansz J.A. stated:

> The Divisional Court did say that mathematical precision was not required, but it seems to me the court thought it necessary the Tribunal be able to make calculations using quantitative orders of magnitude that proved that road mortality would lead to a decline in the population resulting in eventual extinction. I do not accept that. *It was for the Tribunal to decide whether the qualitative indications of magnitude the experts proceeded upon provided an adequate base for their conclusions.* [emphasis added]

The Director maintains that the issue in *Ostrander* was whether evidence on population numbers of a threatened species was required to prove harm, and takes the position that this is a different test than the test to be applied by the Tribunal in this proceeding. However, the Director provided no analysis to further explain this position. The Tribunal does not accept the Director's interpretation. The Court, in *Ostrander* clearly found that it was within the Tribunal's jurisdiction to rely on a qualitative assessment as an evidentiary base for its conclusions.

IFR Flight

[112] A considerable amount of evidence was led respecting the issue whether the proposed placement of the wind turbines would have safety impacts when designing instrument approach procedures that must be approved for use by NAV CANADA before they are published for use by pilots. Mr. Simpson, Supervisor of Flight Procedure Design at NAV CANADA, testified that overall, NAV CANADA did not object to the proposed location of the wind turbines, as they did not affect instrument approach procedures maintained by NAV CANADA to the extent that accessibility to the CRA would be impacted beyond reason.

[113] For the following reasons, the Tribunal does not find it necessary to further consider the evidence regarding IFR flight, as it relates to the application of the Health

Test. Mr. Simpson confirmed that NAV CANADA's review of instrument flight approaches does not include assessment of circumstances where the flight does not conform with regulations, or emergency situations "such as could be induced by inadvertent Visual Flight Rules flight into meteorological conditions not suitable for application of Visual Flight Rules or an inability of an aircraft to maintain required altitude in the event of a mechanical failure." The Tribunal notes that such flight circumstances are precisely the type of situations that other expert witnesses have testified in this appeal could lead to wind turbine collision or wind turbine-induced loss of navigational control.

[114] Furthermore, neither aerodrome has an air traffic control tower, so a pilot flying IFR would still need to confirm the location of other pilots flying in the circuit and ensure that the runway is clear. The Unicom radio system is available for this purpose, but its efficacy depends on the frequency by which other pilots broadcast their locations. Consequently, the Unicom still needs to be supplemented by maintaining visual contact with other pilots within the circuit. In addition, the vast majority of flights at both aerodromes (approximately 90 per cent for CRA) are conducted using VFR.

[115] In summary, the Tribunal notes that a qualitative assessment of whether harm will occur requires a practical consideration of the circumstances in which such harm could occur. In this case, the circumstances in which harm could occur include when pilots fly under VFR or must supplement their IFR flight visually.

Whether the Health Test is met Based on the Current Profiles of the CRA and Clearview

<u>Review of Expert Evidence</u>

[116] The Tribunal begins with the expert opinion evidence adduced in this proceeding by a climatologist, a public safety risk assessor and aeronautical professionals: engineers, pilots, risk assessors and safety specialists. A total of 15 experts testified, each providing extensive evidence. As noted earlier, the expert opinion provided is based on qualitative assessments. All experts provided a considerable amount of information and technical data to support their analyses and conclusions.

[117] Regarding the CRA, Mr. Cormier gave his opinion that “there is a significant and unacceptable risk that there will be an aircraft collision with a turbine or the ground at CRA…” Mr. McKechnie expressed a similar opinion. Mr. Hatcher opined that the proposed position, height and proximity of these turbines to CRA and Clearview so drastically removes the buffers of safety built into the aerodrome circuit system that safety is hopelessly compromised, resulting in a threat to human health. Mr. Gascoine expressed his opinion as follows:

> Based on my experience, I foresee an accident at CRA due to the presence of turbines in the proposed locations. In particular, I believe that new pilots or pilots with limited familiarity with the CRA would be most susceptible to an accident involving turbines. I believe that the most likely scenario will include marginal or deteriorating weather, making an approach to CRA more challenging (although still within VFR guidelines). The presence of the turbines will complicate landing procedures including locating and tracking the turbines, moving above or around the turbines, or failing to track other aircraft using non-standard approaches. All of those issues can lead to pilot error. All of these hazards are exacerbated in moderate or deteriorating weather.

Respecting Clearview, Messrs. Duncan and Hutton stated that the planned location of the proposed wind turbines removes the capacity of the safety system to absorb errors or adverse factors that can lead to accidents. They further noted that there will be little room for any error margins in an already accident prone system.

[118] Mr. Pereira stated that “[i]n my experience in over 200 accident investigations, it is clear that when inadequate margins for safety are present, accidents *will* occur.” This assertion was not disputed by any of the other experts who testified in this proceeding.

[119] Messrs. Duncan and Hutton provided extensive evidence on the factors that contribute to accidents, which include human factors. This evidence was not disputed, and is accepted by the Tribunal. Mr. McDonald did not dispute that pilot error must be considered. Messrs. Duncan and Hutton also discussed in detail Mr. McDonald’s analysis of safety. In summary, they observed that Mr. McDonald “errs when he focuses only on what pilots should do, and does not address what pilots in fact do.” As noted by Mr. Pereira, “Mr. McDonald’s analysis provides little margin for safety and

appears premised on the assumption that such small margin of safety is adequate." The Tribunal finds that these observations provide a fair characterization of this aspect of Mr. McDonald's evidence. For this reason, the Tribunal accepts the evidence of Messrs. Duncan, Hutton, and Pereira to the extent that it conflicts with the evidence given by Mr. McDonald.

[120] In support of this finding, the Tribunal notes that the majority of Mr. McDonald's evidence focused on IFR and instrument approach procedures, and the obstacle limitation surface. On the issue of safety under VFR conditions, Mr. McDonald stated:

> Hundreds of thousands of flights per year are operated in North America safely every year by trained pilots operating under VFR conditions, without incident. And, as noted earlier, under VFR conditions it is the pilot's responsibility for obstacle avoidance.

In addressing the proximity of the wind turbines to the Clearview the take off and approach surface zone, Mr. McDonald stated:

> The seven wind turbines lie outside the approach and landing obstacle limitation surfaces. As such, this aerodrome has the same level of safety for visual approaches and departures along the approach and departure path, *provided an aircraft does not stray west of the runway centerline*. Thus, a standard left hand circuit for Runway 34 and a non-standard right hand circuit for Runway 16 will keep the aircraft outside and clear of the wind turbines as obstacles. [emphasis added]

[121] Mr. McDonald does not then address the issue of pilot error in determining whether an aircraft will not stray west of the runway centre line. As Mr. Pereira points out in his reply witness statement:

> However, this assumption is clearly wrong – pilots using Stayner [Clearview] aerodrome will face a myriad of factors that could lead to aircraft straying outside the specified approach and departure geometry that McDonald prescribes as being safe for installation of the wind turbines. Any accidental straying into the wind turbine area that is in close proximity to approach and departure paths during such events would have a high probability of causing a fatal accidental impact with the turbine
> blades or tower.

> The approach centreline is an imaginary line toward which a pilot aims. Pilots on approach are constantly adjusting and correcting, and the centreline is rarely maintained especially when hand-flying as all airplanes coming into Stayner would likely be. Given the very close proximity of the turbines (the closest turbine is approximately 300m from the centre of Runway 16 and less than 100m from the edge of the approach surface), it would take little error for an aircraft to be on a collision course with a turbine - a miscalculation, distraction, or an insufficient adjustment to a crosswind would do it.
>
> Given the proximity of the turbines, the pilot would have very little time to correct any errors. In a light aircraft at typical approach speeds (which vary between aircraft), the aircraft will cover 100m in a few seconds.

Mr. Cormier expressed a similar view.

[122] There are other deficiencies in Mr. McDonald's analysis. Regarding the location of the wind turbines near Clearview's runway he stated:

> The Stayner Airport [Clearview] cannot meet any aerodrome certification standard not because of the wind turbines but due to the man-made structures and trees close to the runway surface. Setting that issue aside, the turbines lie outside the balance of the obstacle limitation surface for this runway (transitional and approach/landing) making the wind turbines benign in so far as an aerodrome and runway classification is concerned.

Regarding the trees and existing structures, Mr. Cormier testified that they do not impede access to the runway. In other words, in approaching the runway, once a plane descends to that low an altitude, it would be situated on the runway. Apart from this, Mr. McDonald clearly presumes that the proposed wind turbines are safe, simply because they meet regulatory standards. Whether the wind turbines lie outside the transitional and approach/landing surfaces is disputed by the Appellants. However, this is not a material consideration. The Tribunal has already observed that compliance with the regulatory regime is not necessarily indicative of whether the Health Test has been met. In terms of whether serious harm will be caused, the material question is whether the proposed locations of these wind turbines are too close to the runway at Clearview causing serious harm through collision with a wind turbine or the ground. It is clear that wind turbines 3 and 7 border on the boundary of the takeoff/approach surface.

[123] In focusing solely on the regulatory regime, Mr. McDonald has overlooked the impact of wind turbine-induced turbulence. As already noted, Dr. Cox agrees the locations of wind turbines 3 and 7 are unsafe and cannot be supported, which completely contradicts Mr. McDonald's view that the proposed location of the wind turbines near the Clearview runway are "benign".

[124] As noted above, Mr. McDonald observed that hundreds of thousands of flights per year are operated in North America safely every year by trained pilots operating under VFR conditions, without incident. However, in a proper risk analysis, one also has to consider the accidents that have occurred. For purposes of the Health Test, even one incident of serious injury or death would satisfy the Health Test. Mr. McDonald did not provide any data on the incidence of accidents or near accidents, whereas Messrs. Duncan and Hutton have.

[125] Mr. McDonald also stated that "[t]here are scores of examples where certified airports have the outer surface penetrated and mitigation measures are implemented". He then cited, as examples, several airports that have obstacles, including wind turbines, or mountainous terrain, near the runway. The Tribunal finds this evidence to be of little assistance. First, there is no indication in his evidence that a standard similar to the Health Test was applied when approving the layout of these airports. Secondly, the evidence adduced in this proceeding underscores that an aerodrome's risk profile includes a variety of factors: the type of general aviation traffic using the aerodrome, the volume of traffic, the experience level of pilots using the aerodrome, unique meteorological conditions, etc. In the context of applying the Health Test, therefore, one cannot assume that the experience at one aerodrome would be the same at another. Certainly, in this case, Mr. McDonald's evidence did not provide a sufficiently detailed description of the profile of each airport to establish that they are, in fact, similar to the profile of either CRA or Clearview.

[126] Another deficiency in Mr. McDonald's analysis is found in his analysis of lake-effect snow storms. Mr. McDonald stated:

> Another theme is the rapidly changing weather near Collingwood with the presence of eight wind turbines. I have no reason to doubt that the lake effect snow squalls can turn a sunny day into a blizzard quickly. I would tend to think however that the conditions that create this phenomenon are well known – wind blowing over the lake towards Collingwood, open water, cold land mass, etc. Therefore, while the weather can change rapidly it is also predictable with the appropriate conditions. The wind direction must be key, short term variable that triggers this phenomenon. The lake is either open or not but it is the wind direction that causes it to suddenly occur.

This analysis does not accord with the evidence given by the climatologist, Mr. Mawson. Mr. Mawson's evidence indicates that lake-effect storms occur when a confluence of meteorological conditions occurs: air and water temperature, as well as wind direction. Also, Mr. Mawson's evidence indicates that, although climatologists can forecast which counties will experience such lake-effect snow storms, determining their exact location is almost impossible. This evidence does not support Mr. McDonald's view that pilots flying at CRA and Clearview should be able to predict when a snow storm will occur at these aerodromes, and ignores Mr. Elwood's uncontradicted evidence that such storms occur unexpectedly with very little advance signs of their on-coming approach. As such, Mr. McDonald's view completely underestimates the safety risk associated with this meteorological condition.

[127] The Tribunal now turns to consideration of Dr. Cox's evidence. Dr. Cox, who testified on behalf of the Approval Holder, is an expert in the area of risk assessment in public safety, energy and transport as well as fluid dynamics and turbulence. He acknowledged that he is not an expert in aviation matters and based his risk assessment analysis on the evidence provided by Mr. McDonald. In other words, he relied on Mr. McDonald's outline of the relevant aviation considerations, and then conducted his risk evaluation based on these considerations.

[128] There are limitations to his evidence. The first is that he has primarily relied on Mr. McDonald's evidence for a description of the aviation issues to be addressed in this proceeding. As he stated in his witness statement, "I was aware that an aviation consultant, Ed McDonald, had also been instructed by WPD's [the Approval Holder's] counsel and that I would be able to refer to his report for facts or findings that might be

required for the purposes of my analysis." More specifically, in the section of his report addressing risk of collision between aircraft and wind turbines, he stated:

> My expertise in this regard is as a mathematical modeler of risks, but I do not claim expertise or knowledge of all of the systems or activities that I am asked to analyse. Therefore, in response to this type of request it is my practice to collaborate with other experts with specific experience and knowledge of the industry sector in question. In this case, the Legal Counsel to WPD have instructed Mr. Ed McDonald P.Eng. who is an expert in the field of aircraft navigation and operations. I have had the opportunity to read his Witness Statement.

[129] In this regard, his witness statement confirms the documents he reviewed in preparing his assessment which includes the witness statements of Messrs. Lajoie and Elwood (both fact witnesses), and Mr. Green who provided a risk assessment. Notably, he did not review the witness statements of the aviation specialists who testified on behalf of the Appellants. Therefore, Dr. Cox's conclusions are not based on a comprehensive overview of the relevant aviation evidence adduced in this proceeding. This has led Dr. Cox to arrive at the following analysis and conclusion:

> Mr. McDonald explains that the proposed wind turbines would not create an obstacle to air navigation that would not be controllable by obstacle identification and avoidance measures that are normal practice in aviation operations. The location of the designated Obstacle Limitation Surfaces that would apply at the two aerodromes if they were certified aerodromes are indicative of the need to identify the wind turbines on aeronautical charts and they would be so identified. That being the case, the risk that I am being asked to evaluate becomes tantamount to the risk that normal air navigation practices are not followed (for reasons of mechanical failure or human error). Those reasons are unchanged in their likelihood of occurrence and therefore I am of the opinion that the risks will not be increased at all, *if the evidence of Mr. McDonald is accepted*. [emphasis added]

[130] To paraphrase Dr. Cox's opinion, he bases his assessment on Mr. McDonald's position that the wind turbines do not present a safety hazard if there is compliance with normal aviation regulations, noting that risk of mechanical failure or human error exists irrespective of whether the wind turbines are present or not. On this basis he asserts that installation of the proposed wind turbines will not increase the likelihood that a collision would occur. The Tribunal notes that, in his report, Dr. Cox did refer to the main safety risk factors that could contribute to a collision (e.g. pilot error or fatigue,

adverse weather conditions, mechanical malfunctions, etc.). His analysis and conclusion was formulated in response to these concerns.

[131] In addressing his analysis and conclusion, the Tribunal first notes that Dr. Cox's analysis is contingent on acceptance of Mr. McDonald's position that the wind turbines would not create an obstacle under normal VFR flight. However, this is the central issue to be determined in this case. As will be discussed below, the Tribunal does not accept Mr. McDonald's position, and, consequently, the Tribunal cannot rely on Dr. Cox's opinion that the wind turbines themselves would not create an obstacle to air navigation.

[132] Secondly, the Tribunal understands that, from a risk assessor's perspective, a determination that there is no incremental risk of harm may have some import. However, in the context of applying the Health Test, the issue is not whether the risk of harm will be *increased* if the proposed wind turbines are installed. The issue is whether a collision with a wind turbine or other wind turbine-induced crash *will* occur. An example is found in Dr. Cox's assertion that:

> … if such a contingency [i.e. main safety risk factors] were to result in an aircraft coming within 150 m of the ground and off-course by at least 765 m, then I consider that the accident is likely to happen in any event and the presence of the wind turbines will make no difference to that.

[133] As noted by Mr. Cormier in his reply witness statement, the presence of the wind turbines will clearly make a difference if, as a result of these contingencies, a plane collides with a wind turbine. He stated:

> Even if an airborne contingency is the cause of an aircraft being at 500 feet in altitude, this would not inevitably result in a fatal crash. Depending on the circumstances, which are too numerous to mention, an aircraft may be able to recover and return to a higher altitude, or it may be able execute a landing in the nearby fields – so long as a nearly 500 foot turbine is not in the way.
>
> On the other hand, if a light aircraft were to collide with a turbine in the air, the obvious result will be catastrophic and fatal.

Mr. Pereira also criticized Dr. Cox's assertion, stating "[i]t appears that Dr. Cox assumes that for an aircraft to stray off course either the pilot or the aircraft must be so incapacitated that a fatal crash is inevitable." The Tribunal further notes that Dr. Cox's assertion involves, to a considerable degree, assumptions regarding aircraft navigation and operations, which he has acknowledged are not within his field of expertise.

[134] Regarding wind turbulence, Dr. Cox relies on a study conducted by the University of Liverpool on behalf the Civil Aviation Authority of the United Kingdom entitled "CAA Policy and Guidelines on Wind Turbines" (February 2016), noting that its findings state:

> The most significant disturbances caused by a wind turbine wake is in its axial direction and manifested as a velocity deficit in the downwind region. Although the wake vortices also caused disturbance velocities in the radial and vertical direction, they are smaller than the axial disturbance velocity.

Dr. Cox also relies on studies conducted by a consulting firm, GL Garrad Hassan, to conclude that it would be appropriate to designate a zone that is a distance equal to 5 rotor diameters (approximately 500 metres) downwind of the turbines as representing the part of the wind turbine wake that should be avoided by aircraft. (See GL Garrad Hassan: *Advanced wake model for closely spaced turbines* (American Wind Energy Association, 2005) and GL Garrad Hassan Canada, Inc.: *Preliminary Turbulence Intensity and Wind Analysis at the Proposed Wainfleet Wind Project* (800532-CAVA-T-01 Issue C, 29 August 2013).

[135] It is Dr. Cox's opinion that there is no risk that the turbulent wakes from the wind turbines will affect flight operations at the CRA. However, he only provided a cursory description of his analysis in support of this conclusion. The Tribunal understands his analysis is as follows. As the wind turbines are designed to turn their blades to face into the wind, the turbulence wake will flow downwind behind the turbine blades. In a standard left-hand turn, where the circuit is located south of the runway, a plane will fly on the downwind leg towards the face of the turbines. Therefore, if a plane is at an altitude of 500 feet above ground, or lower, it would still not encounter wake turbulence because the turbulence zone is behind the turbines. Stated another way, the plane would encounter the wind turbine itself before it reached the turbulence wake behind it.

If a plane's altitude is high enough to fly over the wind turbines, it will not be exposed to the horizontal turbulence Dr. Cox has described.

[136] The Tribunal accepts this analysis as it relates to flying a standard circuit. However, the Tribunal does not accept Dr. Cox's opinion that there is no risk at all from the turbulent wakes at CRA. As Mr. Hatcher posited in his evidence, if a pilot flew a wider circuit and a longer downwind leg to avoid the turbines, and then turned to the base leg, the plane could be located behind the wind turbines. There is also the situation where a pilot, for whatever reason, is not flying the circuit and navigates behind the wind turbines.

[137] There is agreement that the turbulence generated by wind turbines dissipates the further the turbulent air trails from the wind turbine. In the studies discussed by the experts who testified in this proceeding, there is disagreement whether the hazardous part of the wind turbulence trail falls within horizontal distance of 5 rotor diameters, or 10, or more. However, all the experts in this proceeding agree that the trail up to 5 rotor diameters is hazardous. They also agree that research in this is area is relatively new and is still evolving. As discussed in greater detail below, the Tribunal finds that serious harm will occur if it is assumed that the hazardous zone of the wind turbulence trail extends to 5 rotor diametres. Consequently, it is unnecessary to consider whether the hazardous zone extends beyond this distance. For this reason, and because the research in this is area is relatively new and is still evolving, the Tribunal makes no further finding on this particular issue.

[138] Regarding the impact of wind turbine turbulence at Clearview, Dr. Cox initially concluded in his witness statement that "[t]he wakes of the nearest wind turbines will be dissipated to levels that are safe at the location of the Clearview runway, even in the most adverse wind directions." However, in cross-examination, he agreed that turbulence horizontally extending 5 rotor diameters from wind turbines 3 and 7 would penetrate the take off and flight approach surfaces, and, therefore, he could not recommend placement of those wind turbines in their proposed locations.

[139] The Tribunal now turns to the Director's reference to a study described at page 8 the Transport Canada letter, stating:

> As you may be aware, there are numerous articles and studies available regarding the effects of turbulence caused by wind turbines. In February 2011, Transport Canada participated in the "Aviation Safety-risk Assessment of The Effect of Wind Turbines on General Aviation Aircraft", which was included within one of your attachments. The Summary 3.4 concluded: "The safety-risks associated with GA [General Aviation] aircraft operating in very close proximity to wind turbines – in particular, light and ultra-light aircraft – during take-off and landings from aerodromes, are assessed to be from low to moderate significance. The remainder of the safety-risks to GA [General Aviation] aircraft are assessed to be very low." Several strategies to mitigate the hazards and risks were discussed in this document.

The Director did not provide any further submissions regarding how risks characterized as "low to moderate" should be interpreted for purposes of applying it to the Health Test. The Tribunal has already found that the determination of risk depends on case specific factors. The Tribunal notes that the Aviation Safety-risk Assessment referenced in the Transport Canada letter was not adduced in evidence in this proceeding. If any of the parties sought to rely on this Assessment they could have done so. Consequently, the Tribunal is unable to evaluate the degree to which this Assessment would apply to the specific circumstances at the CRA or Clearview, or how the findings of this Assessment are to be interpreted in the context of the Health Test.

<u>Application of the Health Test to Current Operations at CRA</u>

[140] Mr. McDonald does not clearly state a conclusion on whether the Health Test has been met when it is applied to CRA's current operations, particularly with respect to VFR flights. All he said, as previously noted, is that hundreds of thousands of flights per year are operated in North America safely every year by trained pilots operating under VFR conditions, without incident. The Tribunal has already addressed the remainder of his evidence, other than his evidence regarding his suggested mitigation measures (which is addressed below) and found deficiencies in it. The Tribunal accepts the evidence of the Appellants' experts regarding VFR flight. The Tribunal has also adopted the same finding regarding Dr. Cox's evidence respecting the risk of collision

between aircraft and wind turbines. The only evidence of Dr. Cox that the Tribunal has accepted is that wind turbine induced turbulence does not pose a risk for pilots strictly flying a standard circuit pattern at CRA.

[141] The Tribunal now turns to the evidence of the Appellants to evaluate whether they have established that the Health Test has been met. For the following reasons, the Tribunal finds that they have.

[142] The Tribunal begins by re-iterating that evaluating risk in the circumstances of this case necessitates a qualitative analysis. The most probative consideration presented in the Appellants' analysis is that, where a margin for error is inadequate, there is a reduction in the capacity of the safety system to mitigate the consequences of errors or adverse factors that can lead to accidents. The evidence did not indicate that the margin for error can be quantitatively measured, so it must be qualitatively assessed. The evidence indicates that aviation is highly regulated industry, with particular emphasis on risk management. This industry has operated for decades, and the Appellant's safety experts indicate that, when inadequate margins for safety are present, accidents will occur. The Tribunal finds, therefore, that the question to be answered in this case, is whether, in introducing the wind turbines at their proposed locations, the margins for error are adequate.

[143] In answering this question, the Tribunal begins by first observing that, given the high speeds at which planes travel, and the fact they cannot dramatically reduce velocity to avoid a hazard, the most critical consideration is time - the amount of time a pilot has to recognize that there is a hazard, formulate a response to it, and then implement the response in a sufficient amount of time to allow the speeding plane to avoid the hazard. It is for this reason, that the Tribunal has included the calculations of the amount of time between the turbines and the runway. Most of the turbines are only 1 minute or less away from the CRA runway, the maximum time (excluding wind turbines 2 and 7) being only 1 minute and 20 seconds away. In terms of proximity to the CRA circuit, the planes are at most a few seconds away from wind turbines 1, 3, 4, 5, 6, and

8. This time consideration, in and of itself, considerably narrows the margin of error, even under standard flight circumstances.

[144] The Tribunal's next observation is that the proposed wind turbines are to be located in the runway environment, where a pilot's options for navigation are restricted to the required circuit pattern. The flight take off and approach protocols, further narrow the pilot's options as to where he or she can navigate.

[145] The greatest concern for the CRA, aside from the fact the proposed wind turbines would be situated along the circuit path, is the vertical distance between the circuit height (1,000 feet) and the top of the wind turbine (500 feet). This distance is only 500 feet. Mr. Hatcher's analysis indicates that the tolerance for altimeter error is 200 feet, and that pilots can pass their skill demonstration if they are with 100 feet from a given altitude. This means a plane, under normal operating circumstances, could only be as far away as 200 feet from the wind turbines. In addition, local air pressure changes could result in inaccurate altimeter readings. Apart from this, pilots flying VFR are required to remain 500 feet from the cloud ceiling. If the cloud ceiling is lower than 1000 feet, this will also reduce the distance between the plane and the turbines, which further reduces the margin for error.

[146] It is also important to note that pilots flying under VFR are, during the day, required to remain 500 feet from any obstacle. However, the Appellants have led extensive evidence how pilot error, including errors in maintaining the correct altitude, can and do occur, and so pilots do not always comply with this requirement.

[147] Although the analysis is qualitative, such analysis may include quantitative evidence. The likelihood that an activity will result in harm will, in most cases, increase as the frequency of the activity occurs. In this case, there are approximately 13,200 movements (take offs or landings) that occur each year at the CRA and it is anticipated by CRA staff that this activity will increase. Therefore, over the 20-year life span of the Project, there will be at least 264,000 movements at the CRA.

[148] Dr. Cox also provided a quantitative analysis of the predominant wind direction at Collingwood. Utilizing five years of hourly wind speed and direction observations from the CRA, he created a wind rose diagram which indicates that winds at Collingwood are predominantly from the north-west. In order to take off and land into the headwind blowing in this direction, planes would travel the runway in the RN31/13 direction, which, in turn, means, that they would be predominantly flying the left-hand circuit south of the runway and near to the proposed wind turbines.

[149] The risk analysis evidence adduced by the Appellants also indicates that, although an accident may be caused by just one condition or factor, many accidents are the result of a number of factors. For example, a pilot, responding to an engine malfunction, may navigate incorrectly, which in turn leads to a collision. Hence, when considering whether a safety margin is adequate, it is necessary to consider multiple factors. In addition to the above evidence, the Appellants have adduced extensive evidence to establish these relevant factors which include:

- 90 per cent of flights are conducted under VFR;
- as the predominant wind direction at the CRA is north-west, the left-hand circuit that is predominantly used is situated south of the runway, bringing planes flying at the CRA in close proximity to wind turbines 1, 3, 4, 5, 6, and 8;
- a majority of pilots using the CRA runway hold recreational or private pilot licences, which require minimal on-ground and air flight training;
- students at flight schools located the CRA do their flight training there;
- students from other flight schools, fly (without an instructor) to the CRA as part of their cross-country flight training;
- there are special meteorological conditions at the CRA, most particularly the lake-effect snow storms;
- the individual capabilities of the pilots, their state of mind and body (fatigue, stress, distraction, health) affect how they navigate;

- navigation is affected by: (i) aircraft capabilities and structural tolerances (as stated by Mr. Pereira: “the GA [general aviation] community is filled with vintage planes or home built aircraft);

- navigation is also affected by the physical condition of the aircraft (as stated by Mr. Pereira: “Most aircraft will be pilot maintained, without the same level of quality control or expertise found in commercial airlines”);

- CRA is an uncontrolled airspace that provides only limited weather reporting services; and

- pilot work load is at its highest when flying the flight circuit.

[150] The Tribunal notes that each of the above factors addresses one of the following considerations:

- conditions resulting in a pilot flying very near the wind turbines;
- pilot inexperience, which would lead to a pilot requiring more time to recognize and respond to a hazard; and
- the volume of plane traffic at the CRA, which increases the likelihood that a hazardous situation could arise.

[151] Considering all the above factors, the Tribunal accepts that the margin for error posed by introducing the proposed wind turbines at their proposed locations would be inadequate to prevent collision with a wind turbine. For this reason, the Tribunal accepts the opinions of Mssrs. Cormier, Hatcher and Mr. Gascoine that serious harm will occur.

[152] The Appellants’ experts have each provided an informed and reasoned evidentiary base to support their qualitative assessments. Therefore, the Tribunal finds that the Appellants have established, on a balance of probabilities that the Health Test has been met as it is applied to the current operations at CRA. The next step is to determine whether the mitigation proposals proposed by the Approval Holder would

lead the Tribunal to conclude that likelihood of such harm can be reduced. This step is discussed below, but the Tribunal first turns to the application of the Health Test to current operations at Clearview.

Application of the Health Test to Operations at Clearview

[153] In terms of time, all the turbines, with the exception of wind turbine 2 are 15 seconds or less from the runway centerline at Clearview. The Tribunal has already rejected Mr. McDonald's opinion that placement of the eight wind turbines in relation to the Clearview runway are "benign". Dr. Cox agrees that the proposed location of wind turbines 3 and 7 are unsafe and cannot be supported. The Director has accepted this evidence and no longer supports the proposed placement of these two wind turbines. The Tribunal has also rejected Mr. McDonald's opinion that the visual approaches and departures along the approach and departure path at Clearview are safe, provided an aircraft does not stray west of the runway centerline. The Tribunal has accepted Mr. Pereira's evidence that pilots rarely maintain flight on the centre line, and that it would take little error for an aircraft to be on a collision course with a turbine due to a miscalculation, distraction, or an insufficient adjustment to a crosswind. In this regard, the Tribunal further notes that, even if wind turbines 3 and 7 were removed, straying west of the runway centreline could also bring a plane within the 5 diameter turbulence zone of any of wind turbines 1, 4, 5, 6 and 8. In light of Mr. Pereira's evidence, the Tribunal finds that the margin for error is inadequate.

[154] In addition to these concerns, the Tribunal notes that many of the other safety factors cited above regarding CRA also apply to Clearview.

[155] Wind turbine 2 is 1,917 metres from the runway centre line. It is located on the east side of the runway where the left-hand circuit pattern is located. The evidence adduced does not indicate that wind turbine 2 would be located under the left-hand circuit flight path. But, the left-hand circuit path does result in planes in being considerably closer than 1,917 metres to wind turbine 2. Consequently, the Tribunal finds that wind turbine 2 is sufficiently close to the left-hand circuit pattern that safety factors such as pilot inexperience, pilot error, and meteorological conditions suggest

that its greater distance from the runway does not decrease the risk of harm that it presents to any significant degree. In this regard, the Tribunal notes that wind turbine 2 is only 31 seconds from the runway centreline. Its proximity to the left-hand circuit path is considerably less than 31 seconds.

[156] For these reasons, Tribunal accepts that the margin for error posed by introducing the proposed wind turbines at their proposed locations would be inadequate to either prevent collision with a wind turbine, or prevent a crash due to wind turbine-induced turbulence.

[157] The Appellants' experts each have provided an informed and reasoned evidentiary base to support their qualitative assessment. Therefore, the Tribunal finds that the Appellants have established, on a balance of probabilities that the Health Test has been met as it is applied to the current operations at Clearview. As with CRA, the next step, therefore, is to determine whether the mitigation proposals proposed by the Approval Holder would lead the Tribunal to conclude that likelihood of such harm can be reduced.

<u>Consideration of Proposed Mitigation Measures</u>

[158] For CRA, Mr. McDonald suggested three mitigation options:

> (1) maintain a left-hand circuit pattern, but require a "tighter" circuit path, so that slower flying Category A and B planes will not fly over the wind turbines. "Tighter" means that the cross-wind and base legs would be shortened. Because Category C and D planes are faster aircraft, they cannot fly a tighter circuit, so Mr. McDonald suggests they fly the circuit pattern over the wind turbines, but at a higher elevation (1,500 feet above ground, instead of the standard 1,000 feet);
>
> (2) as a variation of Option 1, slower Category A and B plans would fly the tighter left-hand circuit, and faster Category A and B planes would fly a non-standard right-hand circuit; and
>
> (3) maintain a standard left-hand circuit for RN13/31, and a non-standard right-hand circuit for RN31/13. This would place the circuit path on the north side of the paved runway irrespective of the runway direction.

[159] Regarding option 2, Mr. McDonald stated that this VFR flight pattern was used at an airport in Edmonton, which is now closed. However, Mr. Hatcher noted that Mr. McDonald failed to indicate that this airport "was the first certified aerodrome in Canada established in 1929, a time when tall buildings and other such structures in the downtown core did not yet exist."

[160] In support of his proposed mitigation measures, Mr. McDonald stated:

> The bottom line is that there is tremendous flexibility to move the circuit to the circumstance. Many airports have unique issues that result in nonstandard circuits – Collingwood is not unique in this respect. The key is this information being promulgated in the appropriate publication.

It is clear, therefore, that Mr. McDonald maintains his position that, as pilots are required under the CARS to inform themselves of the traffic pattern at an aerodrome and avoid obstacles, that his proposed measures are safe. However, he does not otherwise provide any analysis evaluating their impact on safety, more specifically, whether these mitigation options would reduce the likelihood of harm occurring at the CRA and Clearview aerodromes.

[161] In response to the first and second proposed mitigation measures, Mr. Cormier stated:

> … The assumption that the circuit will be a perfect rectangle is wrong. The specific path of a circuit is quite variable as it can depend on winds, weather conditions, ceiling, clouds, obstructions, air traffic ahead and on the runway, and pilot experience. Thus it can be expected that any circuit, be it wide, long, short, or tight, will vary by any type of aircraft under different conditions and piloting styles. There is no line on the ground to guide the pilot, and he must adjust to circumstance.
>
> A standard left-hand circuit to Runway 31 with any aircraft category will always come very close to the turbines, and added workload for a pilot to be vigilant. If there is an altimeter error or an emergency such as loss of engine power, or a sudden deterioration of weather, the 500 foot obstacles just are too close. …
>
> Standard practices promote safety, and any variation introduces risk.
>
> …

> Finally, established circuit patterns on the north side of the runway for both runways 13 and 31, and also the turf runway, would cause proximity to the turbines when aircraft join the circuit from the south, as they must still overfly the aerodrome and could easily come in proximity to the turbines.

[162] In response to the third mitigation measure, Mr. Cormier stated:

> Two different circuit directions to the same runway introduce the potential for head-on collision on the final turn. Such an arrangement would not be supported by Transport Canada.

[163] The Tribunal finds that Mr. Cormier has provided informed criticisms of the proposed mitigation measures that were not contradicted by the Director's or Approval Holder's experts, and, therefore, the Tribunal accepts Mr. Cormier's evidence in this regard. As such, the Tribunal finds that there is insufficient evidence that mitigation measures will be effective.

[164] In addressing these proposed mitigation measures, the Tribunal must address whether they are feasible. Options 2 and 3 both require implementation of a right-hand circuit pattern. However, as previously noted, under the CARS, which is federal *law*, not a merely a policy guideline, a right-hand circuit can only be implemented with approval of the Minister of Transportation. There is no such approval in place for either Clearview or CRA and neither aerodrome operator has indicated that they intend to apply for such approval.

[165] As previously noted in this Order, the Transport Canada Letter notes that a right-hand circuit pattern is one way to mitigate the impact of obstacles. In its submissions, the Director characterizes this as a suggestion. If "suggestion" is to be interpreted as indicating that Transport Canada expressed a predisposition to approve a right-hand circuit, the Tribunal rejects this submission. The Transport Canada Letter was carefully worded. It states:

> The aerodrome operator could request a right hand circuit pattern be published for runways 19 and 31 to avoid the obstacles. Such procedures would have to be approved by Transport Canada.

There is nothing in this wording to indicate that Transport Canada recommended a right-hand circuit. As previously noted in this Order, no other evidence was adduced in this proceeding to indicate that a right-hand circuit would be approved by the Minister of Transportation, as required under Part 602.96 of the CARS.

[166] Having found that the Health Test has been met in respect of both CRA and Clearview, the Tribunal cannot simply assume that the Minister's approval would be given, nor can the Tribunal evaluate the proposed mitigation measures by deciding itself that a right-hand circuit is acceptable. The reason for this is obvious. If the Tribunal were to confirm that the Director's decision to approve the REA, based on an assumption that a right-hand circuit would be implemented, the Project could proceed, notwithstanding that a right-hand circuit may never be approved. Consequently, the Tribunal finds that mitigation options 2 and 3 are not feasible as there is no indication that a right-hand circuit will be approved by the Minister.

[167] In further support of this finding, the Tribunal relies on the evidence that, although right-hand circuits are not unsafe *per se*, they are less safe than a left-hand circuit, which better maximizes a pilot's field of view. Therefore, a right-hand circuit does reduce, to some degree, a margin of safety in VFR flight. Also, the Appellants' evidence is that the use of standard procedures promotes safety. Introduction of a right-hand circuit is non-standard procedure, which also reduces to some degree, a margin of safety in VFR flight. Consequently, it is not surprising that: (i) there is a legal requirement to obtain the Minister's approval before a right-hand circuit can be implemented; and (ii) only three to four per cent of aerodromes in Canada have received approval for a right-hand circuit.

[168] The evidence adduced in this proceeding does not address whether the Approval Holder could apply for approval of a right-hand circuit. If, indeed, only an aerodrome operator can apply for the Minister's approval, the Tribunal recognizes that the Approval Holder would be prevented from presenting mitigation options that require the implementation of a right-hand circuit. However, as previously noted, neither the Approval Holder, CRA or Clearview can control the use of another person's property.

This observation brings the conclusion in the Transport Canada Letter into sharper focus. It states:

> In conclusion, based on the information reviewed, it appears there would likely be an operational impact on both the Collingwood and Stayner [Clearview] aerodromes. There are aerodromes in Canada where obstacles are located in proximity to runways, and depending on their location, have continued operation with the establishment of specific procedures, and the marking, lighting and publication of these obstacles. However, it should be noted that such mitigation can result in a decrease in the usability of the Collingwood and Stayner aerodromes. *The Department also wishes to emphasize that it is critical that planning and coordination of the siting of obstacles be conducted in conjunction with an aerodrome operator at the earliest possible opportunity.* [emphasis added]

[169] In the alternative, even if the evidence was that a right-hand circuit could be implemented, based the Tribunal's acceptance of Mr. Cormier's evidence above, the Tribunal finds that none of the mitigation options proposed by Mr. McDonald would significantly reduce the likelihood of a collision with a wind turbine.

[170] The Tribunal now turns to consideration of Mr. McDonald's mitigation proposal for Clearview. He states that "a standard left hand circuit for Runway 34 and a non-standard right hand circuit for Runway 16 will keep the aircraft outside and clear of the wind turbines as obstacles."

[171] As this proposal includes implementation of a right-hand circuit, the Tribunal first notes that its analysis regarding the feasibility of implementing a right-hand circuit equally applies to Clearview. Consequently, the Tribunal finds that, on this basis alone, Mr. McDonald's mitigation proposal for Clearview is not feasible.

[172] In the alternative, even if the evidence was that a right-hand circuit could be implemented, the Tribunal, for the following reasons, finds that this proposal would not significantly reduce the likelihood of a collision with a wind turbine, or ground crash caused by wind-turbine induced turbulence for all wind turbines other than wind turbine 2.

[173] The Tribunal begins by noting that this proposal would result in the flight circuit always being west of the runway, whereas the wind turbines are located east of the

runway. However, the runway is part of a right-hand circuit. The Tribunal has already found that the Health Test has been met, based on the proximity of wind turbines 1, 3, 4, 5, 6, 7, and 8 to the Clearview runway. As such, the introduction of a right-hand circuit does not address any of the harms that led the Tribunal to find that the Health Test has been met in respect of these wind turbines. The Tribunal also notes that its analysis of the impacts of introducing a right-hand circuit on the margin of error in VFR flight, apply to Clearview as well.

[174] Consequently, the only harm that Mr. McDonald's proposed mitigation would address is with respect to wind turbine 2. The Tribunal has found that the likelihood of harm associated with this wind turbine is its proximity to a left-hand circuit path on the east side of the runway. As Mr. McDonald's proposed mitigation would restrict circuits to the west side of the runway, the likelihood of this harm would be mitigated.

Conclusion on Issue No. 1

[175] As the Tribunal has found that the Health Test has been met in respect of the current operations at CRA and Clearview, and that the Approval Holder's proposed mitigation measures in respect of both aerodromes will not significantly reduce the likelihood that such harm will occur, or, if there is some reduction in the likelihood of harm, the reduction is not to a degree that would result in the Health Test not being met, the Tribunal finds that the Appellants have met their onus to establish that the Health Test has been met in respect of the Project's effects on persons using both aerodromes.

Issue No. 2: Whether engaging in the Project in accordance with the REA will cause serious and irreversible harm to bats

Evidence

Introduction

[176] The Appellants allege that the Project will cause serious and irreversible harm to bats through collision mortality. It is not alleged that harm will occur through disruption or destruction of bat habitat. Although the Appellants allege harm to all bats, the Appellants' evidence focuses on three endangered bat species in Ontario: little brown myotis (also known as "little brown bat"), northern myotis, and eastern small-footed myotis.

[177] The Tribunal received evidence from four expert witnesses with respect to the impacts of the Project on bats. The Tribunal qualified these witnesses to give opinion evidence, as follows:

a. Dr. Shawn Smallwood, on behalf of the Appellant, Wiggins, was qualified to give opinion evidence as an ecologist with experience in avian wildlife behaviour and conservation;
b. Dr. Brock Fenton, on behalf of the Appellant, Wiggins, was qualified to give opinion evidence as a biologist with expertise in bat behaviour and ecology;
c. Ms. Sarah Mainguy, on behalf of the Appellant, Preserve Clearview Inc., was qualified to give opinion evidence as an ecologist with expertise in wildlife surveys and impact assessment, including bats; and
d. Dr. Scott Reynolds, on behalf of the Approval Holder, was qualified to give opinion evidence as an expert on bats and the impacts of wind energy projects on bats.

The Director did not call evidence on this issue.

Background

Bat Species and their Status as Species at Risk in Ontario

[178] The evidence indicates that there are eight bat species that are present in Ontario. Five of these species are seasonal hibernators. These species spend their active season on the landscape and are inactive in underground hibernacula during the winter months. Two of these hibernating bat species, the little brown myotis and the northern myotis, were listed as endangered under the *ESA* in 2013. The eastern small-footed myotis and tri-colored bat are also listed as endangered under the *ESA*. In Ontario, there are also three species of migratory tree bat. They spend their active season on the landscape and migrate south each autumn. None of the migratory tree bat species is listed as at risk provincially or nationally.

[179] As noted by Dr. Reynolds, the seasonal hibernators have seen population declines throughout the eastern United States and Canada due to an invasive fungal disease known as White-Nose Syndrome (“WNS”). WNS has eliminated approximately 80% of the hibernating populations of bats in the northeastern United States, including over 70% of the little brown myotis and up to 98% of the northern myotis populations. In Canada, within the region of the Project site, Dr. Fenton suggested that WNS has eliminated 90% to 95% of the little brown myotis population. It is predominantly the impact of WNS on these bat populations that led to their listing as endangered under the *ESA*.

Habitat and Foraging Behaviour

[180] Like other seasonal hibernators, little brown myotis are found on the landscape throughout the summer months and travel regionally to hibernate for the winter months. The distance that these bats travel between their summering range and their wintering hibernacula is highly variable, with the location of hibernacula dependant on the geology (natural caves) and land-use history (subsurface mines) of the region. Little brown myotis roosting habits are flexible, however, maternity colonies (adult females and their

young) are generally found in buildings and other human structures, although they will use large trees as well. Data collected by Dr. Fenton in Ontario suggest that little brown myotis are more commonly found in areas with buildings than areas without buildings. Little brown myotis, like all other bats in Ontario, are nocturnal. They feed (i.e. forage) at night on insects. Little brown myotis generally fly at less than 2 metres off the ground, but may fly higher, when commuting from their roosts or when foraging. They generally forage within 1-2 km of their daytime roosts and are commonly found foraging over open water rather than over field or forested habitat. Dr. Reynolds pointed out that historically, little brown myotis were widespread across most of Ontario.

[181] Regarding the northern myotis, Dr. Reynolds stated that they have many of the same ecological preferences as the little brown myotis, although they show a stronger preference for forested habitat. Northern myotis are relatively uncommon in southern Ontario and tend to be more active in forested habitat than in agricultural habitat. Similar to little brown myotis, the distance between their summering range and wintering area is highly variable and dependent on the availability of suitable hibernacula. Northern myotis generally use relatively large decaying trees for maternity colonies and often change roost trees throughout the summer. They tend to rely on one or two primary roost trees surrounded by multiple alternates within their home range. They generally commute very low to the ground and avoid crossing open habitat, but may forage within or above the tree canopy to capture insects.

[182] Regarding eastern small-footed myotis, Ms. Mainguy stated that like other hibernating bats in Ontario, this species has likely suffered population declines due to WNS. She stated that eastern small-footed myotis were very rare in 1993 when the *Atlas of the Mammals of Ontario* (Federation of Ontario Naturalists, 1994) was prepared and is likely very rare now. She stated that the current population of the species is unknown.

[183] Dr. Fenton pointed out that, in terms of life history, bats are slow reproducing. The bat species that occur in Canada usually have one litter per year of one or two young. Some studies demonstrate that up to 60% of bats in temperate areas do not

survive their first year, but those that do survive may live for more than 30 years. Dr. Fenton stated that these realities mean that their populations are vulnerable to additional fatalities and their populations grow extremely slowly.

Presence of Bats within the Project Site

[184] The Approval Holder did not undertake pre-construction acoustic surveys of bats at the Project site. However, its Natural Heritage Assessment and Environmental Impact Study, dated January 2012 (the "NHA"), lists, at Appendix C, little brown myotis and northern myotis as wildlife species that are present in the region and, at Appendix B, includes, based on the Approval Holder's records review, northern myotis as a species of conservation concern at the Project site. It does not identify little brown myotis or eastern small-footed myotis as potentially being specifically present at the Project site or of conservation concern generally.

[185] Ms. Mainguy asserted that it is likely that little brown myotis and northern myotis, and possibly eastern small-footed myotis, occur at the Project site. She stated that on two occasions during visits to the Project site, she identified little brown myotis there. Citing the *Atlas of the Mammals of Ontario,* Ms. Mainguy gave evidence that little brown myotis and eastern small-footed myotis have historically been present in the Project area. She testified that bats, including, in her opinion, little brown myotis, likely roost in buildings in the vicinity of the Project. She stated that she identified guano in the attics of buildings in the vicinity of the Project, which she identified as being consistent with being from little brown myotis. She also stated that she visually identified little brown myotis on two separate occasions at locations in close proximity to the Project. Dr. Reynolds and Dr. Fenton agreed that, in respect of the little brown myotis, there are likely some of these bats in the area.

Sizes of the Local Populations of Endangered Bats

[186] Dr. Reynolds described the Project site as "predominantly agricultural in land use, with scattered woodlots and some wetland habitat on or adjacent to the Project

site". He stated that it is not prime bat habitat. He stated in regard to little brown myotis:

> … it is unlikely that a large resident population currently exists on the Project site. That is primarily due to the lack of maternity roosting structures within the Project site and the fact that the dominant habitat within the Project site and the adjacent area is not the preferred habitat for this species. Furthermore, in general across Ontario, little brown myotis are not nearly as abundant on the landscape as they were previously due to the impacts of WNS. Dr. Fenton suggests in his Witness Statement that little brown myotis are at 5% - 10% of their pre-WNS population levels within the region.

[187] He believes that although little brown myotis are likely present in the Project area, their numbers are low. In response, Ms. Mainguy stated that numbers of bats in a given area are highly variable, depending on insect abundance and habitat. She pointed out that the little brown myotis lives anywhere that trees and water are found and, noting that she has observed this species at the Project site, it is suitable habitat for this species. Dr. Fenton stated that the exact sizes of bat populations are unknown, but that little brown myotis populations in parts of Eastern Canada have been reduced dramatically in recent years.

Findings on Issue No. 2

Presence and Population of Endangered Bats in the Project Area

[188] Regarding whether endangered bats are present at the Project site, Dr. Fenton, Dr. Reynolds and Ms. Mainguy agreed that there are likely some little brown myotis there. Regarding the presence and population of the other endangered bat species, there was no agreement among the experts.

[189] There was disagreement over the suitability of the Project site and surrounding area as bat habitat. The Approval Holder's Environmental Effects Monitoring Plan states at page 2.5 that bat mortality at Ontario wind energy operations "is lowest in open farmland away from forests and major waterbodies". Dr. Reynolds stated that the proposed wind turbines will all be located in farmers' fields and not in water bodies or

trees and will not be located in prime bat habitat. He stated that the Project site does not have significant attractants for bats.

[190] Ms. Mainguy disagreed. She stated at para. 14 of her reply witness statement:

> The habitat throughout the study area was composed of interspersed streams, small woodlands, ponds and wetlands (amongst agricultural fields) that would provide foraging habitat for bats. In addition, there were reasonably abundant dead trees and many old buildings in the area that in my experience could support roosting bats.

[191] Referring to the *Atlas of the Mammals of Ontario,* Ms. Mainguy's evidence is that eastern small-footed myotis and little brown myotis have been recorded at the Project site and northern myotis have been recorded in the region in the past. She noted however that eastern small-footed myotis have not been reported there recently. She questioned the comprehensiveness of the site investigation conducted by the Approval Holder's consultant, Stantec, to identify bat hibernacula and roosting sites and the presence of endangered bats in the vicinity of the Project. She stated that Stantec's surveys for bat maternity colonies did not use protocols recommended by the Ministry of Natural Resources and Forestry ("MNRF") and important habitat was overlooked. The NHA states at page 3.13 that the Approval Holder's search for bat roosting sites was confined to within 120 metres of Project infrastructure and did not include searches of buildings. The Tribunal notes that the wildlife assessment notes prepared by Stantec, indicate that trees with cavities were found to be "abundant" in woodlot 2 and "occasional" in woodlots 1 and 5 in the study area, but that no bat habitat was identified. Ms. Mainguy testified that further investigations should have been completed. She also reiterated that the Approval Holder failed to conduct acoustic surveys to determine the presence of bats at the Project site.

[192] Given that the area is predominantly agricultural, and that there is a reduced general abundance of the three species due to WNS, the Tribunal accepts Dr. Reynold's opinion that it is unlikely that there is a large resident population of these species at the Project site and the level of bat activity at the Project site is generally low overall. However, the Tribunal also accepts Ms. Mainguy's evidence that there is

suitable little brown myotis habitat and likely roosting sites in very close vicinity of the Project site.

[193] Given the evidence before the Tribunal that little brown myotis typically forage within 1-2 km to their daytime roosts and reside in areas close to trees and water, their likely roosts have been identified and at least one individual recently sighted in the vicinity of the Project area, and as agreed by Dr. Fenton, Dr. Reynolds and Ms. Mainguy, the Tribunal finds that it is more likely than not that there is a small population of little brown myotis at the Project site and its vicinity. Regarding the presence of northern myotis and eastern small-footed myotis at the Project site, no evidence was presented to the Tribunal of roosting sites or of these species being recently sighted in the vicinity of the Project site. Although there is evidence that the trees and wetlands in the area could be habitat for these species, the Tribunal has insufficient evidence to conclude that northern myotis or eastern small-footed myotis more likely than not are present.

Whether the Project will cause Serious and Irreversible Harm to Endangered Bats

(1) Serious Harm

[194] As noted in previous Tribunal decisions, including *Fata v. Ontario (Environment)*, [2014] O.E.R.T.D. No. 42 and *Hirsch v. Ontario (Environment and Climate Change),* [2016] O.E.R.T.D. No. 6, at para. 141, consideration of "serious harm" is determined "on a case by case basis, using discretion and weighing all relevant factors". The Tribunal stated in *Hirsch*, at paras. 154-155:

> In *Monture*, the Tribunal discussed what degree of harm would meet the threshold for serious and irreversible harm. At para. 80, the Tribunal stated that the threshold is "not automatically satisfied by demonstrating that one bird or bat mortality will occur. This finding does not preclude the possibility that a single mortality in some circumstances will constitute 'serious and irreversible' harm. Whether the threshold has been met must be determined on the individual circumstances of each case." In the present case, the fact of the status of Little Brown Bat as endangered is an important consideration in assessing the seriousness of the Project's impacts. In *Ostrander*, the Divisional Court, in referring

to the threatened Blanding's Turtle, stated, at para. 35 (emphasis added), which was agreed to by the Court of Appeal:

> It seems unquestionable from the evidence that was placed before the Tribunal that there was a risk of serious harm to Blanding's turtle from the project. *Given the fragile status of Blanding's turtle as a* species*, it would be difficult to characterize any increase in mortality arising from the Project as anything other than serious.* The real issue is whether that harm was also irreversible.

The Tribunal has addressed the issue of whether impacts on bats constitute serious harm in several past decisions. Although concerns were dismissed regarding bat populations in *Bovaird*, *Fata*, *Lewis* and *PECFN*, the Tribunal views the circumstances in the present case as distinct from those in past Tribunal decisions. Since those decisions, the species has continued to decline. The witnesses agreed that Little Brown Bat populations have declined quickly and precipitously due to White-nose Syndrome. The Tribunal accepts Dr. Fenton's opinion that incidental bat mortality will occur with the Project and that this would be scientifically significant for Little Brown Bat, when considered at a local scale. Dr. Strickland did not disagree that incidental mortality will occur, but stated that the numbers will be small. With only 5 to 10% of the historic population remaining, the Tribunal finds that an increase in mortality of even small numbers of Little Brown Bat constitutes a serious impact.

[195] In *Assn. for the Protection of Amherst Island v. Ontario (Ministry of the Environment and Climate Change)*, [2016] O.E.R.T.D. No. 36 ("*Amherst Island*"), the Tribunal distinguished the findings in *Hirsch* observing that both evidence of the presence of endangered bats and the proposed mitigation measures differed between the *Hirsch* and *Amherst Island* projects. In *Amherst Island*, the Tribunal stated at paras. 182-183:

> This case is distinguishable from the White Pines project in *Hirsch* both because of the disparity in the evidence of harm to bats and the proposed turbine curtailment mitigation measures discussed above. The unique pro-active curtailment mitigation measures to be deployed from the outset of the operation of the Project are an encouraging development for the protection of bats. The Tribunal finds, based on the evidence heard, that a large proportion of potential bat mortality will be addressed as a result of this mitigation.
>
> The Appellant's argument is that even a small number of mortalities and small amount of habitat disruption will, over the life of the Project, cause serious and irreversible harm to bats. As indicated, the evidence is that there is a limited presence of SAR [species at risk] bats on the island, and the evidence is that bats use the island only for foraging and/or migration. To conclude, the Tribunal finds that the Appellant has not demonstrated on the evidence that engaging in the Project in accordance with the REA

> will cause serious and irreversible harm to bats, including Little Brown Myotis, Northern Myotis, and Tricolored bat species.

[196] In the present case, as noted above, the Tribunal has found that there is more likely than not a small population of little brown myotis that are present at the Project site and there is evidence that these bats roost in buildings in the vicinity of the Project site. The issue is whether the Project will cause serious harm to this small population.

(i) Likelihood of little brown myotis fatalities caused by the Project

[197] Dr. Reynolds summarized research that he conducted 10 years ago in New Hampshire on little brown myotis. At that time, he found that the little brown myotis population in New Hampshire was growing slightly. He analyzed the population impacts post-WNS and what the likely effect of fatalities from it would be, given the recovery potential of the population. He stated that his study showed that short of a plateauing of effect, regionally there would be a “quasi-extinction of this population in 16 years”. However, he also stated that more recent data shows that a plateauing effect may indeed presently be occurring and that some little brown myotis populations are stabilizing at about 3 to 5% of their pre-WNS levels.

[198] The evidence before the Tribunal includes records from Bird Studies Canada that show until recently, dead little brown myotis were consistently found at wind energy facilities in Ontario and in fact that the species was consistently one of the bat species with the highest mortalities in the province. Dr. Fenton testified that such evidence confirms that little brown myotis are susceptible to collisions with wind turbines. Since 2010, the number of dead little brown myotis found at these sites has declined, likely reflecting their dramatic drops in population. However, the Tribunal finds that the Bird Studies Canada evidence demonstrates that little brown myotis are susceptible to wind turbine strikes and, given the presence of little brown myotis at the Project site, the Tribunal finds that the Project will cause little brown myotis fatalities over the lifespan of the Project.

(ii) Effects of Little Brown Myotis Fatalities on the Local Population

[199] Dr. Reynolds stated his opinion that serious harm is harm that is "biologically significant". He stated, in terms of biologically significant harm, the important question is whether the operation of the Project will in any way alter the slope of the population trajectory of endangered bat species. Dr. Reynolds observed that there is no evidence that the level of mortality to little brown myotis at wind energy facilities has in anyway accelerated the rate of decline or lowered the rate of recovery of this species. He also stated that the current level of mortality to this species from wind energy facilities in general is incidental, and is not biologically significant. He concluded, therefore, that any foreseeable fatality of this species at the Project site would not cause any serious, let alone serious and irreversible harm.

[200] All of the bat experts who appeared before the Tribunal agreed that wind turbines are not the primary threat to the viability of little brown myotis populations in Ontario. However, the evidence before the Tribunal is that these populations are vulnerable due to the decimation of their populations caused by WNS. Ms. Mainguy stated:

> With populations so critically low, it is likely that any additional mortality would eliminate breeding adults that have survived white nose syndrome, which would be critical to the persistence of the population.

In her evidence, she further stated that the remaining breeding adults have survived WNS and could potentially carry resistance to it and that, therefore, their protection from harm is critical to any possible recovery of the species. She testified that the introduction of a known source of mortality into an already critically low population of little brown myotis would have a high probability of causing serious harm to the species. She stated that the population of little brown myotis is "catastrophically small" and any further bat deaths would harm the local population. Dr. Smallwood opined that the species cannot tolerate any more fatalities and Dr. Fenton testified that the species has become more vulnerable in the past three years and that any further mortality will hasten local extinction of the species.

[201] Although he stated that, without knowledge of species population sizes, “we cannot appreciate or describe the impact of mortality at wind farms”, Dr. Fenton testified that there are endangered bat species of bats in the area which are vulnerable and “will surely be seriously and irreversibly harmed by the development in the absence of robust amelioration actions”.

[202] Dr. Reynolds agreed regarding the vulnerability of the species, predicting that unless local population levels plateau, the little brown myotis will be regionally extirpated by 2026. As noted above, he added that there are now indications that some local populations are starting to plateau.

[203] Section 5(1)3 of the *ESA* refers to an “endangered species” as a species that lives in the wild “but is facing imminent extinction or extirpation”. The Tribunal finds that vulnerability of such a nature exposes these species to serious harm where it is shown that they will suffer any additional fatalities. The Tribunal accepts the Approval Holder’s evidence that WNS has caused the local little brown myotis population to become vulnerable, but finds that based on Dr. Reynolds' evidence that populations may be plateauing and Ms. Mainguy’s evidence that the remaining individuals are either those that have avoided WNS or are resistant to it, fatalities caused by the Project will have serious harm to the local population. This finding is in line with the reasoning of the Ontario Divisional Court in *Ostrander* (as noted above in *Hirsch* at para. 154), where the Court stated in regard to serious harm to threatened Blanding’s turtles:

> Given the fragile status of Blanding’s turtle as a species, it would be difficult to characterize any increase in mortality arising from the Project as anything other than serious.

The Tribunal notes that the “endangered” status of little brown myotis categorizes this species as more at risk and with a more fragile status than the “threatened” Blanding’s turtle referred to in *Ostrander*.

[204] The threshold test in s. 145.2.1 of the *EPA* protects vulnerable species such as little brown myotis. The Tribunal finds that this interpretation, and its application to the

local population of little brown myotis present at the Project site, is consistent with the purpose of the *EPA* to provide for the conservation and protection of the natural environment.

[205] Given the vulnerability of this species and the likelihood that the Project will cause fatalities, the Tribunal finds that without adequate mitigation measures, the Project will cause serious harm to the local population of little brown myotis.

(iii) Adequacy of the Project's Mitigation Measures

[206] In *Amherst Island*, the proponent committed to undertake preventative mitigation measures to reduce the risk of harm to endangered bat species. In its Mitigation Operation Plan, dated November 2015, supplementing the renewable energy approval, post-construction monitoring was increased beyond that required under the impugned renewable energy approval for the periods of highest risk to endangered bat species, precautionary blade rotation cut-out in low wind conditions were required for times that these species are active, and there would be increased curtailment of operations in instances where there are additional bat fatalities by raising the wind speed at which turbines would commence operation.

[207] Dr. Fenton testified to the importance of undertaking all possible mitigation measures to reduce the risk of harm to bat species at risk. He testified that we must do anything that we can to mitigate impacts on the species. He stated at para. 11 of his witness statement:

> … it would be irresponsible not to use any feasible approaches to mitigate the impact of wind turbines on populations of [little brown myotis]. Failure to mitigate will effectively jeopardize the long term survival if this species by causing local extirpation.

[208] Under the present REA, the mitigation measures of curtailing operations or feathering blades would not be triggered until 10 bat fatalities are recorded per turbine over the course of one year. The Tribunal accepts Ms. Mainguy's and Dr. Smallwood's

evidence that bat fatalities are often under-estimated by post-construction monitoring. This fact is also noted in the EEMP.

[209] Ms. Mainguy questioned the effectiveness of the REA's mitigation measures. She stated at page 10 of her "Report on Peer Review of Fairview Wind Farm: Endangered Bat Species", dated April 2016, which was attached to her witness statement:

> Proposed mitigation for mortality of endangered bat species due to wind turbines would not be effective, as excessive mortality would not be detected until the end of each year, potentially after considerable mortality of adult breeding bats had taken place. Breeding adults are likely to be extremely important for populations of endangered bat species, as they are individuals that have survived white nose syndrome: the only individuals that could potentially carry resistance to the fungus. In addition there is no evidence that thresholds that have been set for acceptable bat mortality at each turbine would be sustainable in the long term for endangered bat species, especially considering the context of cumulative impacts of wind turbines throughout Ontario.

[210] The Tribunal notes that unlike in *Amherst Island*, neither the REA nor any supplementary commitments made by the Approval Holder require that preventative mitigation measures be implemented from the outset of the Project's operations in order to reduce the harm that the Project will cause to endangered bat species. Under Condition I5 of the REA there must be 10 bat fatalities of any species per turbine for mitigation measures to be triggered. Although endangered species fatalities must be reported to MNRF, such circumstances do not trigger any mandatory mitigation measures under the REA. Based on the evidence before the Tribunal regarding the vulnerability of the local little brown myotis population at the Project site, the Tribunal finds that, on a balance of probabilities, this high threshold for triggering mandatory mitigation measures will not prevent serious harm being caused by the Project to the local little brown myotis population.

[211] Regarding the REA's requirement that an *ESA* authorization be obtained as a mitigation measure, the Tribunal notes that although Dr. Reynolds testified that some little brown myotis are likely present at the Project site, no evidence was presented to the Tribunal on whether authorizations under the *ESA* have been sought by the

Approval Holder regarding possible impacts on this endangered species caused by the Project's operation. The Tribunal notes that the NHA was conducted in 2012 prior to the listing of little brown myotis as an endangered species under the *ESA* and that the NHA does consider little brown myotis as a species of conservation concern. Condition J1 of the REA requires that the Approval Holder ensure that Project activities requiring authorization under the *ESA* will not commence until the necessary authorizations are in place. The Tribunal notes that the issuance of such authorizations does not necessarily address the issues that the Tribunal must consider under s. 145.2.1 (2) of the *EPA*. Given that no such authorizations have been issued, it is not possible for the Tribunal to assess whether such authorizations in this case would mitigate impacts of the Project to little brown myotis or specifically address the threat of extirpation of the local population of this species.

[212] In *Amherst Island*, the Tribunal found that bats were known to forage in the vicinity of the wind energy project and that there was suitable habitat there to support their life processes, but there was insufficient evidence to determine that there would be fatalities or, if there were fatalities, that they would be at a level that would cause serious and irreversible harm. Like in *Amherst Island*, the population of little brown myotis at the Project site is small; however, in the present case, preventative mitigation measures are not in place equivalent to those set out in the supplementary commitments made by the approval holder in *Amherst Island*. In *Amherst Island*, the Tribunal found that the approval holder's commitment to preventative mitigation measures ensured that bat fatalities, if any, would be minimal. The Tribunal finds that the mitigation measures as set out in the REA are not as protective as those in the supplementary commitments made for the wind energy project in *Amherst Island*, which the Tribunal finds are more up-to-date and consistent with the environmental protection and conservation purposes of the *EPA*. The Tribunal notes that if similar measures were put into place for the Project, the Tribunal may have found that harm would be reduced below the threshold of serious harm.

(iv) Conclusions on Serious Harm to Bats

[213] Given the evidence before the Tribunal on the presence of little brown myotis in the vicinity of the Project site, the history of fatalities of this species at Ontario wind facilities, and the absence of progressive preventative measures to reduce the risk of harm to this endangered species, the Tribunal finds that engaging in the Project in accordance with the REA will cause serious harm to the local population of little brown myotis over the lifespan of the Project.

(2) Irreversible Harm

[214] The test under s. 145.2.1(2) requires that the Tribunal determine both whether a project will cause serious harm and also whether it will cause irreversible harm. As noted by the Court of Appeal in *Ostrander*, data on population numbers are helpful for determining whether a population can recover from harm, but where such data is not available, the Tribunal may rely on expert opinion in making this determination.

[215] In the present case, the Tribunal has determined that little brown myotis is present at the Project site and the species is in danger of extirpation. Dr. Fenton stated that population data on little brown myotis in Ontario does not exist, but he and Dr. Reynolds agreed that its population in Ontario has been reduced by 90 per cent and that the local population in the vicinity of the Project site is small. It therefore stands to reason that the number of little brown myotis fatalities that will be caused by the Project will be low.

[216] Dr. Reynolds stated that any foreseeable bat mortality at the Project site would not cause any irreversible harm. He stated that any incidental mortality caused by the operation of the Project would not alter the slope of the population trajectory of little brown myotis and is therefore not irreversible.

[217] Dr. Fenton and Ms. Mainguy each testified that for little brown myotis to recover from WNS, much will depend on the continued viability of the remaining, healthy, population. Dr. Fenton stated at paras. 9-10 of his witness statement:

> The impact of WNS jeopardizes the long term survival of some species of bats, to the point that any additional mortality (e.g. at turbines) is not acceptable from a conservation standpoint. Our lack of knowledge about the size of the populations of different species of bats precludes specifically quantifying the risks turbines pose to the long term survival of populations of bats.
>
> […]
>
> Populations of [little brown myotis] appear to be about 5 – 10% of their pre-2010 levels. Additional mortality, such as that associated with wind turbines, will jeopardize the survival of this species which has been so negatively affected by WNS.

[218] Ms. Mainguy stated that increased mortality of breeding adult little brown myotis would likely cause irreversible harm to the local population of this slow-reproducing species. She stated at page 7 of her "Report on Peer Review of Fairview Wind Farm: Endangered Bat Species", which was appended to her witness statement, that "[m]ortality of breeding adults would likely result in irreversible harm to the local bat populations in the vicinity of the wind turbines", reiterating at page 10 that "[b]reeding adults are likely to be extremely important for populations of endangered bat species, as they are individuals that have survived white nose syndrome: the only individuals that could potentially carry resistance to the fungus".

[219] The Tribunal accepts Dr. Reynolds' view that little brown myotis fatalities caused by the Project will be low, but also accepts the evidence of Dr. Fenton and Ms. Mainguy that any recovery of the local population from WNS depends on the continued viability of the remaining, healthy, population. Relying on the evidence of Dr. Fenton, who was acknowledged by Dr. Reynolds as the expert on local little brown myotis populations, and Ms. Mainguy, the Tribunal finds that the number of little brown myotis fatalities will not be incidental, but rather will impact the trajectory of the local little brown myotis population. Based on the agreed evidence of both Dr. Fenton and Dr. Reynolds regarding the endangered status of the species, the Tribunal finds that even small-scale

impacts on the local population of little brown myotis will decrease its chances of recovery over the lifespan of the Project.

[220] The Tribunal finds that over the lifespan the Project, it is more likely than not that the Project will cause serious harm to the local population of little brown myotis from which it will not recover and cannot be reversed. Therefore, without additional mitigation measures in place, the Tribunal finds that engaging in the Project in accordance with the REA will cause irreversible harm to little brown myotis.

Conclusion on Issue No. 2

[221] Based on the evidence before it, the Tribunal finds that engaging in the Project in accordance with the REA will cause serious and irreversible harm to animal life, plant life or the natural environment under s. 145.1(2) of the *EPA*.

Remedy Hearing

[222] In *Ostrander*, the Court of Appeal found, at para. 97:

> I also agree with the Divisional Court that, given the broad and varied range of attacks launched against the REA, it was not realistic to expect the parties to address the appropriate remedy at the end of the hearing of the merits without knowing what the Tribunal's findings were in regard to the broad range of alleged harms. Without the contributions of the parties on the question of remedy, it is not surprising the Tribunal found itself "not in a position" to consider the full range of remedial options.

[223] The Tribunal notes the Court's finding does not state that a further hearing to address remedy is required in every case. As noted by the Court, the Tribunal in *Ostrander* specifically noted that it was not in a position to consider the full range of remedial options. The Tribunal, in this proceeding, considers that the range of alleged harms is narrower, so the parties could have addressed the appropriate remedy at the hearing of the merits. Nevertheless, given the volume of evidence adduced, and the fact that many of the issues in this proceeding have not been addressed in detail in previous renewable energy appeal proceedings, the Tribunal is prepared to provide an

opportunity for the parties to make further submissions on appropriate remedies, should the Approval Holder or the Director request such an opportunity.

[224] The Tribunal, therefore, adjourns this proceeding to a telephone conference call ("TCC") to determine the next steps in this appeal, to be scheduled by the Tribunal Case Coordinator. In order to ensure that there is sufficient time to hold a remedy hearing before the statutory deeming provision takes effect, the Tribunal adjourns this proceeding, pursuant to O. Reg. 359/09, s. 59(2)1.ii, effective from the release date of this Order, to the date of the next scheduled TCC.

ORDER

[225] The Tribunal finds that the Appellants have satisfied the health test and the environment test in respect of little brown myotis under s. 145.2.1(2)(a) and (b) of the *EPA*. The Tribunal, therefore, allows the appeals in part.

[226] Subject to any further order of the Tribunal, this proceeding is further adjourned under s. 59(2)1.ii of O. Reg. 359/09 to a telephone conference call to be arranged by the Case Coordinator. At that time, if a remedy hearing is required, the Tribunal will discuss procedural steps for the hearing of submissions with respect to the appropriate remedy, pursuant to s. 145.2.1(4) of the *EPA*.

Appeals Allowed in Part

Hearing Adjourned

"Dirk VanderBent"

DIRK VANDERBENT
VICE-CHAIR

"Hugh S. Wilkins"

HUGH S. WILKINS
MEMBER

Appendix 1 - Appellant List
Appendix 2 - Proposed wind turbine locations near Collingwood Regional Airport
Appendix 3 - Proposed wind turbine locations near Clearview Aerodrome

If there is an attachment referred to in this document,
please visit www.elto.gov.on.ca to view the attachment in PDF format.

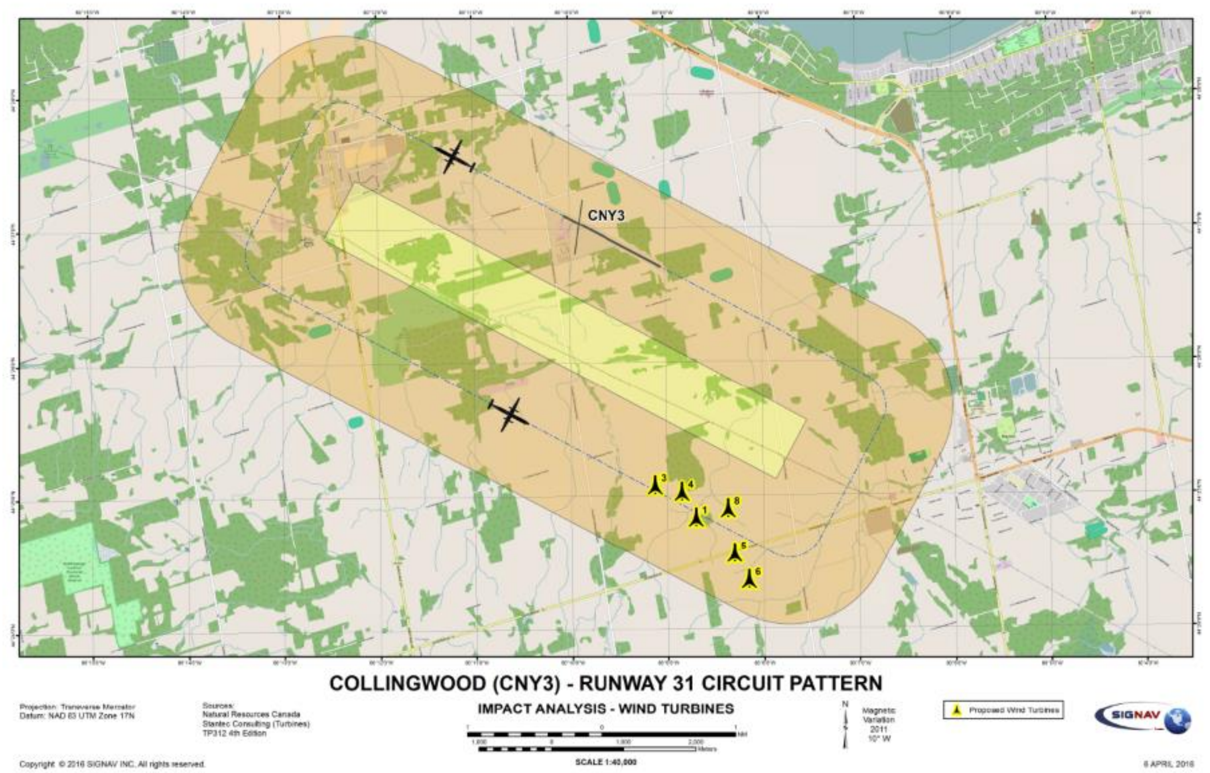
Appendix 1

Appellant List

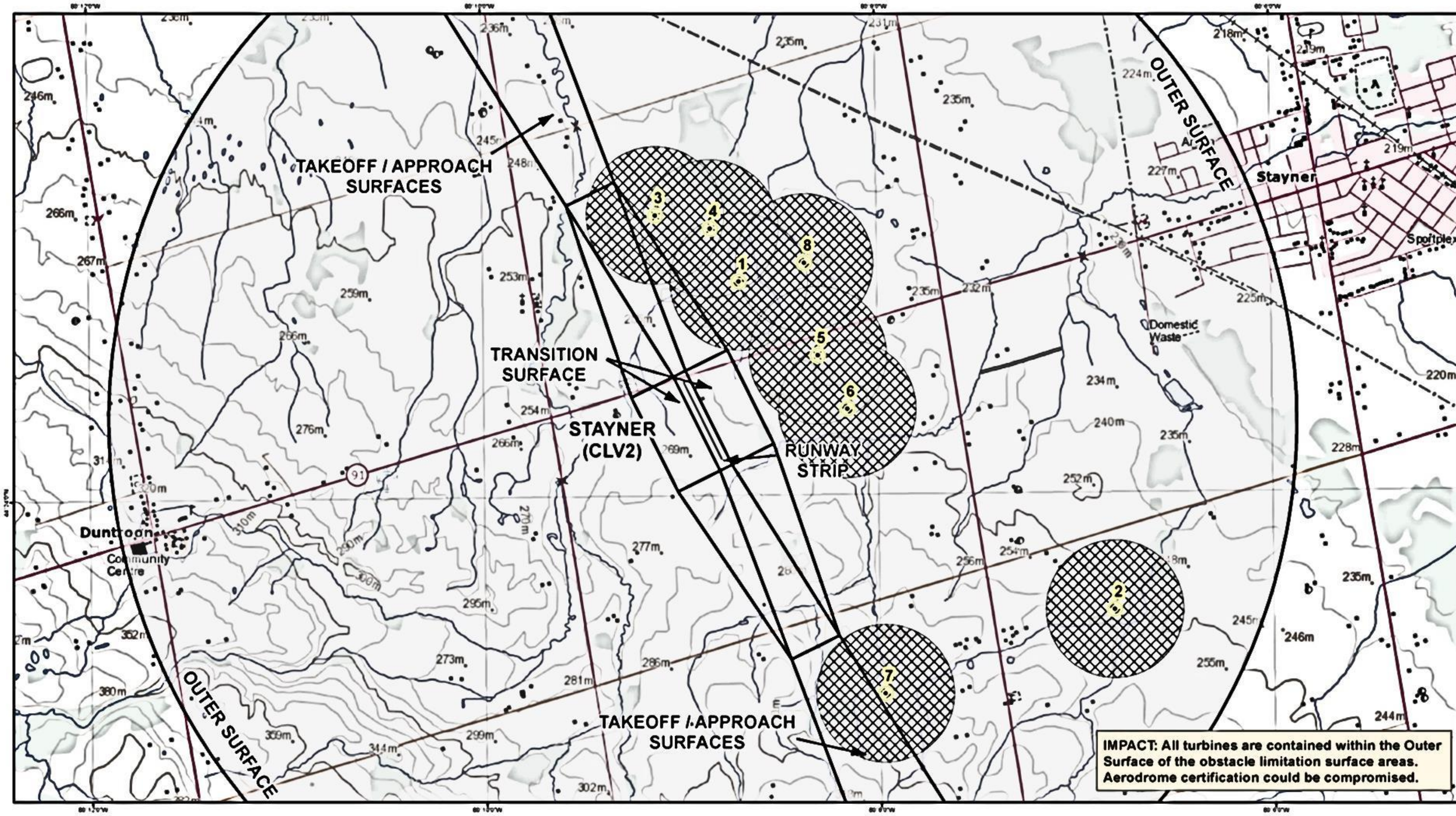
Appellant Name	**File No.**
John Wiggins	16-036
Gail Elwood	16-037
Kevin Elwood	16-038
The Corporation of the County of Simcoe	16-039
Preserve Clearview Inc.	16-040
The Corporation of the Township of Clearview	16-041
The Town of Collingwood	16-042

Appendix 2

Proposed Wind Turbine Locations near Collingwood Regional Airport



Proposed Wind Turbines Locations near Clearview



STAYNER (CLV2) - OLS NON-PRECISION CODE 1

IMPACT ANALYSIS - WIND TURBINES

Projection: Transverse Mercator
Datum: NAD 83 UTM Zone 17N
Contour Interval 10 metres

Sources:
Natural Resources Canada
Stantec Consulting (Turbines)
TP312 5th Edition

SCALE 1:24,000

Magnetic Variation 2011 10° W

Proposed Wind Turbines
Wind Turbines Turbulence

SIGNAV

25 MAY 2016

Environmental Registry # 012-0614
Ministry of the Environment Ref. # 8250-8XUKKC

Fairview Wind Project

Requesting Comments by 01 February 2014

Submission by Kevin & Gail Elwood
8257 County Rd 91, Stayner, ON

Appendix 4.2

Aviation Safety-risk Assessment of The Effect of Wind Turbines on General Aviation Aircraft

SMS Report No. 1101

Produced by

SMS Aviation Safety Inc.
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March 2011

CONFIDENTIAL

FOREWORD

This aviation safety-risk assessment was conducted to support decisions to manage the aviation safety-risks related to the effects of wind turbines on general aviation aircraft. The report contains information that may be proprietary. Recipients of the report are requested to restrict its circulation to those who are involved in decision making associated with wind farm development.

Please direct comments regarding this report to:

Terry Kelly, Managing Director
SMS Aviation Safety Inc.
275 Slater Street, Suite 900
Ottawa, ON
Canada K1P 5H9

EXECUTIVE SUMMARY

The recent growth of the wind energy industry across Canada caused the Canadian Owners and Pilots Association (COPA) to commission a multi-phased independent safety analysis of the effect of wind turbines on general aviation (GA) aircraft. The first phases of the study involved studying technical and operational literature to identify aviation hazards, so that a panel of subject matter experts from the aviation and wind energy industries could assess the associated safety-risks.

This report summarizes the results of the expert panel meeting held in Ottawa on February 10 – 11, 2011. It is intended to be used by government policy makers, wind farm developers and GA pilots to manage the aviation safety-risks associated with the interaction of GA aircraft with wind turbines.

The deliberations of the Expert Panel focussed on the physical hazards of wind turbine structures (i.e., wind turbines as obstacles to aircraft operating at low altitudes, and the potential effect of towers on ground-based navigation aids) and on the effects of the rotating blades of the wind turbines (i.e. turbine-induced turbulence, blade-tip vortices and wind shear).

The expert panel determined that the safety significance of wind turbines on the Canadian Civil Aviation System as a whole is very low. However, they collectively concluded that additional steps are necessary to further mitigate the risks faced by pilots flying GA aircraft. In particular, they determined that the risks to light and ultra-light aircraft operating in very close proximity to wind turbines during take-off and landings are from low to moderate significance. The panel concluded there was a strong need to better inform pilots, aviation and wind energy associations, and government and non-government policy makers on the potential risks to small aircraft caused by wind turbines. Furthermore, they concluded that the development and implementation of minimum setback distances around aerodromes would go a long way to reducing the safety risks to GA aircraft during take-off and landing.

To maximise the effectiveness of new mitigation strategies, the expert panel recommended that stakeholders from the wind energy and aviation industries – including regulatory bodies – better coordinate their activities. This will encourage the development of a systematic approach to wind farm development across Canada, which in turn will streamline the development process, minimize the number of challenges received by regulatory agencies and developers, and improve overall system safety.

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GLOSSARY

AGL	Above Ground Level
ASL	Above Sea Level
ATC	Air Traffic Control
CFS	Canada Flight Supplement / GPH205
COPA	Canadian Owners and Pilots Association
FL	Flight Level
ft.	foot
GA	General Aviation
IFR	Instrument Flight Rules
km	Kilometre
km/h	Kilometres per Hour
Kts	Knots (nautical miles per hour)
MEA	Minimum Enroute Altitude
mi	Mile
m/s	Metres per Second (where 1 m/s equals 3.6 km/h)
MOCA	Minimum Obstruction Clearance Altitude
MVMC	Marginal Visual Meteorological Conditions
MW	megawatts
NM	Nautical Mile (where 1 NM equals 1852 m)
TSR	Terminal Surveillance Radar
VFR	Visual Flight Rules
VOR	Very High Frequency Omnidirectional Range

1. INTRODUCTION

1.1 Background

Pressure to increase the amount of energy generated from alternative sources has led to a growing number of wind farms being constructed across Canada. This has increased the incidence of applications to construct wind turbines within close proximity to aerodromes, including certified aerodromes (airports).

In response, the Canadian Owners and Pilots Association (COPA), whose membership is made up of operators of privately owned general aviation (GA) aircraft and operators of many of the smaller aerodromes from which GA aircraft fly, has attempted to influence approval processes to ensure there are safe distances between wind turbines and existing aerodromes. COPA has achieved mixed success, in part because there has been no comprehensive safety-risk assessment of the effects of wind turbines on GA aircraft.

Consequently, COPA contracted SMS Aviation Safety Inc. to conduct an independent, third-party safety-risk assessment of the issue.

1.2 Purpose

The aim of the safety-risk assessment was to determine whether the risks of wind turbines to GA aircraft warrant a more systematic approach to safety-risk management.

1.3 Scope

The scope of the risk assessment was defined as the effect of wind turbines on general aviation (GA) aircraft[1].

1.4 Method

1.4.1 Overview

The risk assessment was conducted in three phases.

Phase One – Preliminary Hazard Analysis. The first phase involved the preparation of a hazard summary. This document was based on a study of the literature on the effects of wind turbines on the air, operational safety-risk assessments of wind turbines on Air Traffic Services, and texts on general fluid dynamics. The resulting document contained a preliminary list of hazards that can occur as a result of interactions between wind turbines and GA aircraft. The document was provided to the subject matter experts before they participated in the expert panel review.

Phase Two – Expert Panel Deliberations. The expert panel met in Ottawa, Ontario from February 10th to 11th, 2011. The panel was composed of persons with experience in the operation of GA aircraft and helicopters, air traffic control, airspace classification and structure, and the design and operation of wind-powered turbines. A list of the panel member and their affiliations is provided in Appendix A.

[1] A definition of GA aircraft is found in Section 1.4.3. Wind turbines are described in Section 1.4.4 and 2.1.

During the two-day session, the panel:

- received technical briefings related to wind turbines, GA and helicopter operations, and airfield impact assessment;
- used information from the briefings, the hazard summary and the risk assessment framework (described in Section 1.4.2 of this report) to identify the potential hazards and risks that could result from interactions between GA aircraft and wind turbines;
- drew on their experience and the available data to provide information for projecting the severity and likelihood of each risk;
- conducted a preliminary examination of the appropriateness of existing forms of mitigation to manage the aviation safety-risks; and
- discussed ways in which additional mitigation might better manage aviation safety-risks in the future.

Phase Three – Finalization of the Analysis. The analysis was finalised by integrating the information gleaned during the first two phases in a draft report. This report was then provided to the panel members for technical verification and comment. Following this review, the report was prepared in its final form.

1.4.2 Definitions and risk assessment categories

The following definitions were employed:

- Hazard: The condition or circumstance that can lead to loss of life or property.
- Risk: The consequence of a hazard, measured in terms of severity and likelihood.
- Mitigation: The measures taken or available to eradicate a hazard, or to reduce the likelihood or severity of a risk.

The categories outlined in Table 1.1 and Table 1.2 were employed in Section 3 to assess the risks resulting from each hazard.

Table 1.1: Risk Severity

Category	Definition	Description
A	Catastrophic	Destruction of property or loss of life
B	Major	Major damage and / or major personal injury
C	Minor	Minor damage and / or minor personal injury
D	Minimal	Inconvenience

Table 1.2: Risk Likelihood[2]

Level	Definition	Description
1	Occasional	Expected to occur, but not often
2	Seldom	Expected to occur infrequently
3	Remote	Slight chance that it might occur
4	Improbable	Not likely to occur
5	Extremely Improbable	Occurrence is almost inconceivable

1.4.3 Definition of General Aviation

General Aviation (GA) is one of two categories of civil aviation in Canada. The majority of the world's aircraft activity falls into the GA category. GA refers to all aircraft activity, both private and commercial, other than military and scheduled passenger and cargo flights. Some examples of GA are: private recreational flying and personal transportation, business aviation, flight training, air ambulance, police operations, aerial fire-fighting, air taxi, gliding, skydiving and non-scheduled commercial flights.

GA aircraft include gliders, powered parachutes, balloons, helicopters, ultralights, amateur-built (experimental) aircraft, certified piston aircraft and jet aircraft. Pilots flying GA aircraft have a variety of certifications, qualifications and experience.

For the purposes of this report, special operations, such as (non-military) search and rescue or police operations, were not considered to be part of GA; nor were balloon operations.

Even with these restrictions, the definition of GA is broad[3]. Consequently, the report attempts to identify as precisely as possible the specific areas of the GA system (aircraft types, pilots, operating environment, etc.) that can be affected by each hazard.

[2] All of the likelihood ratings are near the "infrequent" end of the frequency spectrum because aviation has earned an enviable record in which training, regulations and multiple layers of defence combine to reduce the likelihood of serious events occurring. By using finer ratings at this end of the spectrum, the expert panel was able to more precisely identify the likelihood of risks occurring, so that mitigation can be effectively targeted.

[3] There were discrepancies noted regarding the definition of GA aircraft even amongst the expert panel. The definition provided by COPA was employed for this report.

1.4.4 Assumptions and Limitations of information and data

The risk assessment was completed using the following assumptions.

"Wind Turbines" were assumed to be of a type similar to those in general use across Canada. Specifically, it was assumed that they:

- are affixed to the ground with a solid structure, usually a tubular steel tower;
- have horizontal rotors of three blades;
- have maximum heights ranging from 120- 150 m (393 - 492 ft.) from ground to uppermost blade-tip[4];
- have hub heights ranging from 80 - 100 m (262 - 328 ft.);
- have rotor diameters ranging from 80 - 100 m (262 - 328 ft.); and
- generate from 1500 – 3000 kW.

It was assumed that pilots operating GA aircraft adhere to the Canadian Aviation Regulations and Standards. However, the panel considered the risks that could arise as a result of such predictable circumstances as encountering reduced visibilities while en route.

It was assumed that GA flights are conducted in day and night conditions, and that GA pilots possess "average" skills and experience.

The impact of a wind turbine on a GA aircraft is not constant. For example, a stationary wind turbine does not disrupt airflow to the same extent as a rotating turbine. Consequently, it was assumed that turbines will rotate 80 % of the time.

Precise quantitative data regarding interactions between GA aircraft and wind turbines were for the most part not available. To determine the hazards of wind turbines, technical information regarding the effects of wind turbines on the surrounding air, and on ground-based air navigation equipment were identified. From this information, the SME panel extrapolated the magnitude and severity of the associated risks to GA aircraft.

It was determined that there was no need to examine the effects of wind turbines on air traffic control radar because the topic has been the subject of a number of recent reports[5].

[4] The vast majority of wind turbines in Canada presently fall within this range. Some countries are beginning to experiment with turbines of similar design but up to 200 m (656 ft.) tall.

[5] For example: Safety Risk Assessment of Three Wind Farms on the Hamilton TSR, SMS Aviation Safety Inc., December 2010

1.5 Report Use and Format

The intent of this report is to inform policy makers, wind farm developers and GA pilots so that they can manage the aviation safety-risks associated with the interaction of GA aircraft with wind turbines.

Section 2 explains the details of the system that was assessed.

Section 3 contains the results of the risk assessment.

Section 4 describes the mitigation that could be applied to reduce the aviation safety-risks, if so desired.

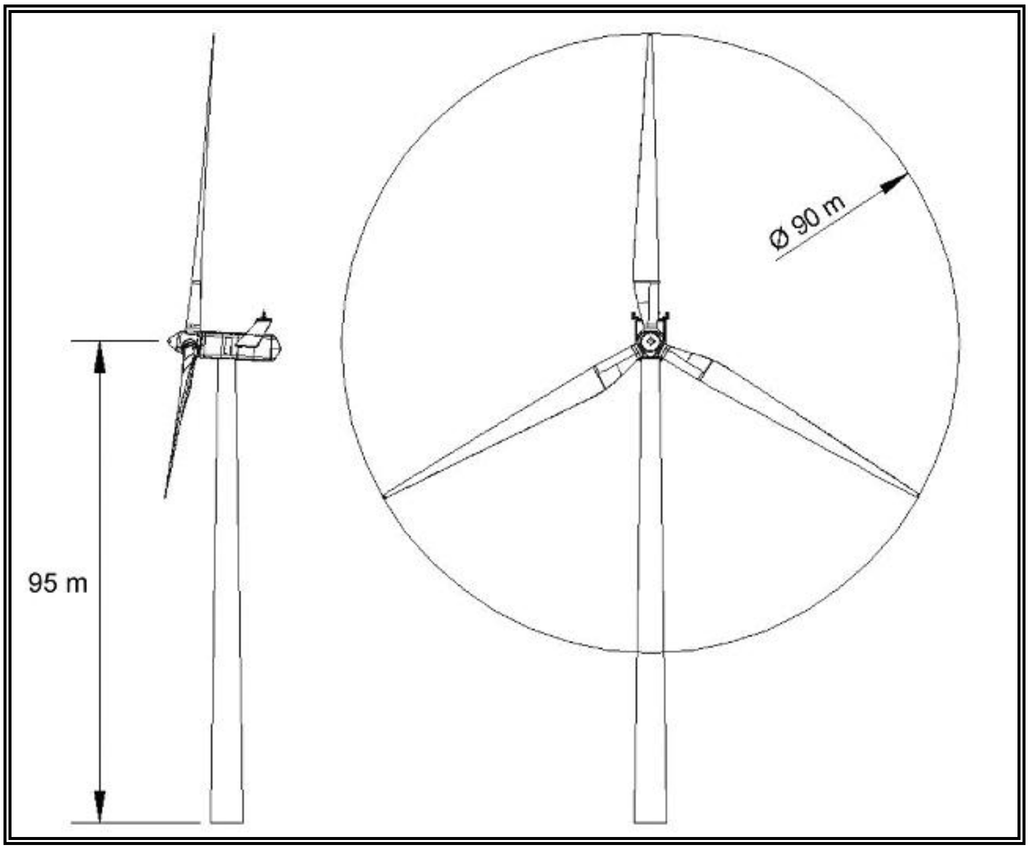
Section 5 provides conclusions regarding the longer-term forecast safety-risks of GA aircraft interactions with wind turbines in Canada.

2. DESCRIPTION OF THE SYSTEM UNDER REVIEW

2.1 Wind Turbines

The wind turbines considered in this assessment are those that conform to the common design currently employed across Canada for electricity generation, an example of which is shown in Figure 2.1. Wind turbines consist of a support tower, normally a tubular steel column, supporting an electrical generator. The generator is connected to the hub, which in turn is connected to three blades. The blades are primarily of composite construction. Depending on the model chosen, these composites can include combinations of lightweight carbon fibre, fibreglass and balsa wood in their makeup. Many turbines have variable pitch control mechanisms that alter the blades' angle of attack to extract maximum energy from the wind. Most turbine blades incorporate a metallic wire to provide grounding in the event of lightning strikes.

Figure 2.1 – Example of Typical Wind Turbine in Canada[6]



Wind turbines are normally equipped with wind vanes that identify wind direction and yaw-mechanisms that rotate the hubs upwind. The rotation of the blades is maintained at a nominal rotation rate, a rate controlled through the variable pitch mechanism and a brake.

Wind turbine blades do not turn all of the time, but instead start turning and generating electricity at wind speeds of approximately 5.8 Kts (11 km/h), and cut out (stop rotating) at wind speeds of approximately 48 Kts (90 km/h). The tips of wind turbine blades reach maximum speeds of around

[6] Vestas V90 wind turbine, source: Vestas Wind Systems A/S.

320 km / h (173 Kts) – this speed is purposely restricted to minimize the noise generated by the blade tips.

Wind turbines are typically located in areas where there is sufficient wind to generate electricity at least 80% of the time. They are normally situated near an electrical grid with the capacity to carry the electricity generated. To minimize losses incurred in transporting electricity, wind turbines are generally located as near to consumers as possible.

The construction of a wind farm typically requires permits from a variety of Federal and Provincial Government agencies, and consultation with numerous stakeholders. For example, constructing a wind farm in Ontario typically requires 30 or more different permits from: the Federal Department of Fisheries and Oceans, Transport Canada, Environment Canada; the Ontario Provincial Ministry of Environment, Ministry of Natural Resources, Ministry of Transportation; Aboriginal People; and others. Transport Canada assesses a wind farm to determine whether the height and location of the proposed turbines will be obstructions to aviation. NAV CANADA assesses wind farm proposals that are submitted through the land use process for their potential effect on the air navigation system (navigation aids, surveillance equipment and communication infrastructure).

2.2 General Aviation in Canada[7]

In 2010, there were approximately 35,000 aircraft registered in Canada, of which approximately 27,000 were GA aircraft. More than 90 % of the total number of aircraft registered in Canada had gross take-off weights of less than 12,500 lbs.

There were roughly 38,000 pilots registered as “non-commercial pilots” in 2010 – pilots who are licensed to fly recreationally. There were nearly 25,000 pilots classified as “commercial pilots”. While these pilots are certified to fly commercially, a large portion of them do not fly professionally, and spend much of their flying time recreationally.

The Canadian Owners and Pilots Association (COPA) had approximately 17,500 members in 2010. Because their members make up a large percentage of all private pilots, COPA members can be considered representative of pilots who fly GA aircraft in Canada.

The average COPA member flies 30 hours each year[8]. For comparison, the average airline pilot in the U.S. flies an average of 75 hours per month[9].

There are over 1800 certified and registered aerodromes in Canada[10] as well as thousands of unregistered aerodromes[11]. The majority of these are privately operated, registered or unregistered aerodromes. These aerodromes range from grass strips in farmer’s fields, to 3,500+ ft. paved runways. Most GA flights take-off and land at these private aerodromes. They are not regulated to the same degree as airports, and are generally not inspected by Transport Canada.

Because the range of operations included in the designation ‘GA’ is large, typical performance characteristics or operations are difficult to describe. Two categories of GA aircraft which make up a large portion of the total, and are more likely to interact with wind turbines, are described below.

The first is made up of small single engine airplanes that weigh under 3,500 lbs. Examples include Cessna 172, Piper Arrow, Beechcraft G36 and Cirrus SR22. These aircraft may be used in a variety of ways, including training pilots, flying recreational site seeing tours, flying supplies into remote

[7] Section 1.4.3 contains a definition of aircraft that are considered to be GA aircraft for the purposes of this assessment.
[8] Source: COPA.
[9] Occupational Outlook Handbook, 2010-11 Edition, December 17, 2009.
[10] Report: Transportation in Canada 2009.
[11] Source: COPA, 2011.

locations, etc. They usually cruise between 3,000 and 13,000 ft. (915 – 4000 m) above mean sea level (ASL) and are governed by visual flight rules (VFR) or instrument flight rules (IFR). They most often interact with wind turbines when taking-off and landing from aerodromes in the vicinity of wind farms, and when carrying out low-level operations such as aerial application (crop dusting).

The second group is ultralight aircraft. Ultralight aircraft are defined as having maximum take-off weights of 560 kg (1234 lbs.), maximum stall speeds of 39 Kts (72 km/h) at maximum take-off weight, and wing areas not less than 10 m^2 (107 $ft.^2$). Ultralights are cost effective aircraft, and are typically flown by amateur pilots with less training and experience than those flying larger aircraft. Ultralights are flown under VFR, and because they are prohibited from certain classes of airspace, tend to fly closer to the ground, often at altitudes less than 5,000 ft. (1500 m) ASL. Ultralights are expected to interact with wind turbines during take-off, landing and cruise.

2.3 Helicopter Operations in Canada[12]

There were approximately 4,800 helicopter pilot licences in Canada in 2008[13]. Over 85 % of these licences were commercial. Unlike airplanes, most helicopters are commercially operated, due primarily to the expense of operating a helicopter.

Helicopters are typically flown close to the ground at typical altitudes ranging from 2,000 ft. to 100 ft. above ground level (AGL).

Helicopters can fly at speeds ranging from 0 Kts. (e.g. aerial photography) to 150 Kts. (e.g. air taxi). Average flight speeds are around 100 Kts (185 km/h).

Most helicopter operations are governed by VFR, but they frequently fly in sub-optimal weather conditions. Visual flight in conditions of 1 mi (1.6 km) flight visibility is not uncommon, and in abnormal circumstance, they may operate with as little as 0.5 mi (800 m) forward visibility. When encountering reduced visibilities, it is normal practice to fly low to the ground.

[12] The panel believed that the assessment of the effects on helicopter operations was essential because much of their flying takes place at low altitudes where they can interact with wind turbines.
[13] Summary of Flight Crew and Air Traffic Control Licenses, Transport Canada, December 2008.

3. ASSESSMENT OF RISK

3.1 Introduction

The risk assessment team identified the hazards (conditions or circumstances that can lead to loss of life or property) associated with the interaction of GA aircraft and wind turbines; determined the risks (the consequences of each hazard, measured in terms of severity and likelihood); assessed the appropriateness of existing mitigation (measures that can be taken to eradicate hazards, or reduce the likelihood or severity of risks), and considered whether additional mitigation was required to address the identified risks.

The panel determined that the safety-risk posed by wind turbines to the totality of aircraft operations in the Canadian Civil Aviation System was low[14]. Only a very small portion of all aircraft movements in Canada are exposed to the effects of wind turbines.

GA aircraft are most exposed to wind turbines, resulting in increased safety-risk to this category of aircraft.

3.2 Hazards Related to the Interaction of GA Aircraft with Wind Turbines

Five system hazards related to the interaction of GA aircraft with wind turbines were identified. These included: physical obstacles to aircraft flying at low altitudes, wind turbine induced turbulence, wind turbine blade-tip vortices, wind turbine induced wind shear, and impact on navigation aids.

3.2.1 Physical Obstacles to Aircraft Flying at Low Altitudes

Wind turbines typically range from 120 - 150 m (394 - 492 ft.) in height above ground (AGL), and their blades cover an area ranging from 5,000 – 7,800 m^2 (54,000 - 84,000 ft^2). Consequently, wind turbines are physical obstacles to low flying aircraft[15].

Wind turbines are situated to take advantage of high average wind speeds. They are frequently sited along high terrain, or in fields where there are few barriers to wind flow. The airspace over the former is frequently used by pilots of small en-route aircraft, who can legally fly as low as 500 feet above the ground (and lower when landing or taking off). The latter is frequently used for aerodromes.

Additionally, wind farms are sited to take advantage of available electrical grid capacity. When possible, they are located near communities where the demand for energy is highest. This has the potential to conflict with airports and aerodromes that are also located close to communities. Consequently, it is not surprising that wind turbines and aerodromes can be in close proximity to each other.

Exposure to this hazard increases as the number and size of wind farms grow[16]. Exposure also increases as the size of wind turbines (i.e. the physical dimensions of individual turbines) increases. Recent technological advances are enabling wind turbines to be higher and larger, and this trend is

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[14] During the assessment, all of the identified risks to aviation as a whole in Canada were judged to be of “low significance” because they were assessed to fall under one of the following categories: A 5; B 4 – 5; C 3 - 5; or D 1 - 5.

[15] A related hazard is meteorological towers, also known as met towers, used by the wind energy industry to obtain wind data prior to constructing wind turbines. These towers are fabricated of steel tubing and supported by guy wires, and can be up to 197 ft. (60 m) tall. Meteorological towers are typically unmarked.

[16] Size of wind farm in this case means the number of wind turbines in a wind farm. Currently, wind farms in Canada range from a few wind turbines up to 70+ wind turbines.

likely to continue, since the amount of energy that can be extracted from the wind increases exponentially as the diameter of the wind turbine rotor increases.

Pilots are at greater risk of striking obstructions when the obstacles are difficult to see. This can occur in low ambient light conditions, or when flying VFR with low ceilings or visibilities (e.g. MVMC). In these circumstances, the risk is increased at locations where wind turbines are constructed near roadways that VFR pilots rely on for navigation.

The colour of wind turbines (usually grey / white) makes them difficult to identify in cloudy or snowy conditions. The relative position of the aircraft to the wind turbine and the horizon may make it difficult for the pilot to detect the obstacle. These conditions are further aggravated when the wind turbines are not depicted on air navigation charts[17].

Aircraft are most exposed to wind turbines as obstacles when the wind turbines are located in areas where aircraft must fly at altitudes equal to or less than the maximum height of the turbines. This occurs most often when wind turbines are constructed near aerodromes.

Most GA aircraft (for example: Cessna 172s, ultralights, etc.) climb relatively slowly. These aircraft generally take an average of 2.5 km (1.6 mi) to climb to 500 ft. (152 m) AGL[18,19]. Furthermore, aircraft on departure and approach are operated closer to their stall speed, limiting the manoeuvrability of the aircraft when avoiding obstacles. Finally, pilots face their highest cognitive demands (task difficulty, time pressure, etc.) during take-off and landing, reducing their ability to adequately deal with additional challenges, such as manoeuvring around obstacles[20].

Certain categories of GA flying such as aerial application (e.g. crop dusting), emergency medical service (EMS), ultralight flights, and float plane operations take place routinely at or below the height of typical wind turbines.

The consequences of an aircraft colliding with a wind turbine would be catastrophic (i.e., a category A loss). There have been no reported occurrences of aircraft striking wind turbines in Canada. The panel was aware of a fatal accident in which an aerial applicator in California collided with a meteorological tower that was gathering data for a wind farm[21].

[17] Although it is standard practice to depict wind farms on air navigation charts, it may be years before a chart is published within the revised information.

[18] The panel noted that 500 ft. AGL is the standard height at which VFR pilots can safely begin a turn after departure. .

[19] The distance to climb to 500 ft. AGL increases during the summer months when air is hotter and less dense.

[20] Loukopoulos et al, 2003.

[21] National Transportation Safety Board report, Identification WPR11LA094, January 2011.

It was determined that without additional mitigation, the risks of relating to wind turbines as obstacles are:

- Aircraft collision with wind turbine components, with the likelihood judged to be improbable[22] (A-4);
- Controlled Flight Into Terrain (CFIT) or Uncontrolled Flight Into Terrain (UCFIT) due to an avoidance manoeuvre near a wind turbine, judged to be either improbable or extremely improbable[23] (A-4/5);
- Pilot distraction due to efforts to judge proximity to wind farm, etc., judged to have a remote chance of occurring (D-3); and
- Extended flight route to avoid wind farms, judged to occur occasionally[24] (D-1).

Panel members examined the existing mitigation, which principally focuses on making pilots aware of the presence of turbines so they can avoid them. The panel concluded that this was inappropriate mitigation for aircraft on departure from or arrival at aerodromes.

Although there is existing regulation from Transport Canada regarding obstacle limitation surfaces around airports[25] to prevent the construction of tall structures, there is no regulation related to protective surfaces around registered or unregistered aerodromes.

Adding protection surfaces for aerodromes would enable GA aircraft to climb to a safe altitude before manoeuvring to avoid wind turbines. These protection surfaces would apply both to wind turbines being constructed near existing runways, and to new runways being constructed near existing wind turbines.

Additionally, the panel concluded there was a need to better inform the wind turbine industry on the risks of building turbines near aerodromes, and pilots about the risks of wind turbines.

Finally, to address wind turbines as obstacles to en-route GA aircraft, the panel believed there was a need to enhance the visibility of wind turbines. Although they did not have the technical expertise to discuss this in detail, they considered the feasibility of adding IR markings to make the turbines visible to special operations pilots flying with night vision goggles[26], and the possibility of enhancing lighting around the perimeter of wind farms.

The panel agreed that mitigation for this hazard would work best in combination (i.e. improved lighting + timely update of charts + education, etc.).

3.2.2 Wind Turbine Induced Turbulence

Electrical energy from a wind turbine is generated when the wind imparts a force on the turbine's blades, which in turn apply torque on a generator. The wind turbine blades impart an equal torque to the wind that passes over them, causing the air to become turbulent[27].

[22] Highest likelihood if wind turbines are located near aerodromes, in bad weather conditions with poor visibility. Ultralights were felt to be at greater risk.

[23] This was judged to be more likely to occur in conditions of poor visibility. If manoeuvre took place during take-off or landing, aircraft designs that are particularly prone to stalling would be more exposed. If manoeuvre took place during cruise, faster aircraft were judged to be more exposed to this hazard.

[24] More likely to occur with aircraft that consistently operate at low altitude, in more heavily populated areas.

[25] TP312 – Aerodromes Standards and Recommended Practices, Transport Canada, March 2005.

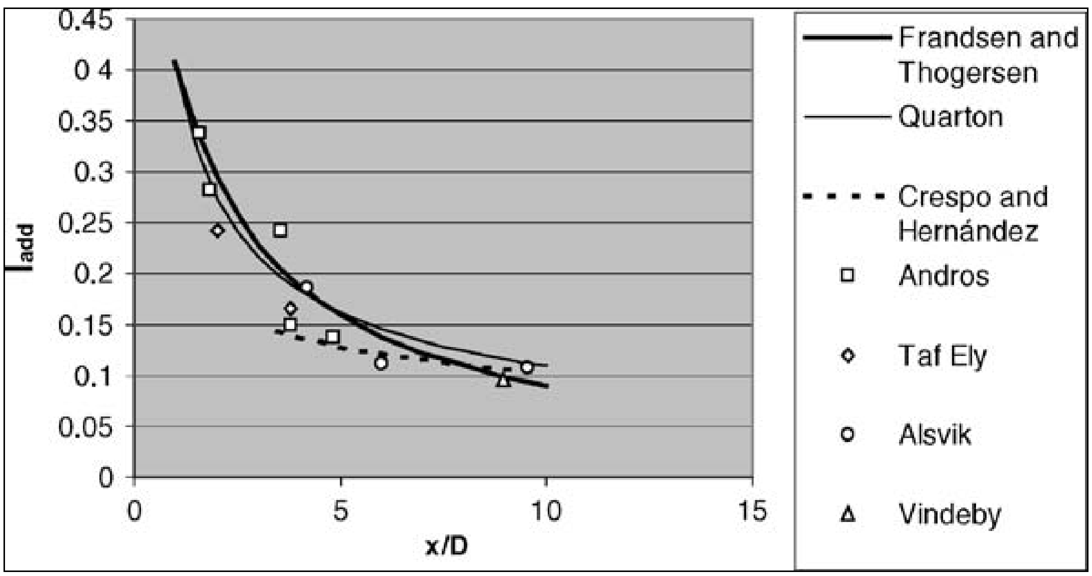
[26] Currently, flying with night vision goggles is not a common practice outside of military aviation.

[27] This comes from Newton`s third law of motion: for every action, there is an equal and opposite reaction.

Studies have shown that the near-field wake turbulence behind a horizontal axis turbine extends up to ten rotor-diameters downstream from the turbine. As would be expected, the strength of the turbulence is stronger in the area immediately behind the wind rotor on the leeward side, and decreases in strength as distance from the rotor increases.

Figure 3.1 illustrates the results of one of these studies[28]. It shows how the strength of turbulence behind a turbine compares to the strength of turbulence in the "free-stream" air (air flowing around the turbine but not coming into contact with the turbine). For example, from the diagram it can be seen that at five rotor diameters from the rotor (x/D = 5), the induced turbulence behind the wind turbine is expected to be approximately 15 %. This means that the induced wind speed fluctuations have a value of 15% of the average wind speed. Under normal conditions, wind contains between 10% and 15 % of ambient turbulence. The total turbulence behind a wind turbine is calculated from the contribution of ambient and induced turbulence, and is normally between 18 % and 21 % at five rotor diameters from the rotor (x/D = 5).

Figure 3.1 – Turbulence Strength as a Function of Distance from a Turbine Rotor



The spacing of wind turbines in a wind farm bears out this analysis. Turbulence reduces the amount of energy that a wind turbine can extract from the air. To maximise power production, turbine separation in a wind-farm is normally eight rotor diameters in the direction of the prevailing wind direction, and three to five diameters perpendicular to the prevailing conditions[29].

Turbulence is strongest on moderately windy days[30]. Turbulence carries on further at times when the general air flow is less turbulent (for example, at night).

Aircraft will be exposed to turbine induced turbulence on the leeward side of the turbine within approximately seven rotor diameters of the turbine[31]. Exposure to turbulence would be greatest for

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[28] Vermeer et al, 2003.

[29] Siting criteria is for 8 rotor diameters downwind, as a tighter spacing reduces energy production and decreases turbine operational life.

[30] Turbulence decreases in high winds due to the increased rotation speed of the rotor: with increased rotation speed, less torque is required to generate the same amount of electrical energy. Turbulence decreases as torque decreases.

[31] The panel determined that turbulence would be a concern for pilots flying at a distance of up to approximately seven rotor diameters, after which pilots would experience the turbulence as little more than a bump.

small, light aircraft travelling at slow airspeeds and at the same height as the wind turbine rotor. This situation could occur when aircraft are landing or taking off from aerodromes with wind turbines in close proximity to the approach and departure paths. It could also occur to a pilot flying en-route who encounters deteriorating weather conditions, and is forced to fly at a low altitude to maintain visual contact with the ground and at slower speed to increase available reaction time for obstacle avoidance. Some aircraft, such as ultralights, cruise at low altitudes, and might be exposed to turbine induced turbulence more frequently.

Turbulence is not visible, so a pilot could inadvertently enter a turbulent zone if they were unaware of the presence of the turbines (e.g., in conditions of low light or visibility) or during take-off and landing at an aerodrome in close proximity to one or more turbines.

It was determined that without additional mitigation, the risks related to wind turbine generated turbulence are:

- Aircraft structural failure brought about by extreme forces applied to aircraft frame or control surfaces[32], judged to be a remote chance of occurring (A-5)
- UCFIT due to loss of control after encountering wake turbulence, judged to be a remote chance of occurring[33] (A-4); and
- Temporary and non-sustained loss of control, judged to have a remote chance of occurring (D-3).

Because the strength of turbulence decreases as distance from the turbine increases, the risks to GA aircraft can be reduced by ensuring that there is sufficient distance between the turbine and the aircraft when the aircraft is at or below the height of the turbine rotor. For this reason, the mitigation for turbulence is similar to the mitigation for turbines as obstacles (3.2.1).

To reduce the risks to aircraft during the take-off and landing phases of flight, mitigation could include minimum setback distances for wind turbines from aerodromes. From the diagram shown in Figure 3.1, the panel determined that a distance of seven to ten rotor-diameters from any runway would be sufficient to reduce the risks related to turbulence to an acceptable level.

To reduce the risks to en-route aircraft, the panel believed the most appropriate mitigation to be pilot education. This would inform pilots about the risks related to turbulence caused by wind turbines, and how to judge safe distances from wind turbines. The panel agreed that to be effective, this mitigation would need to take several forms, including classroom training during flight schools, bulletins from Transport Canada, and newsletters from aviation industry groups.

Similar to the mitigation for turbines as obstacles, the panel agreed that mitigation for wind turbine induced turbulence would work best in combination (i.e. education + improved lighting + timely update of charts, etc.).

[32] Ultralights and homebuilt aircraft are expected to be more susceptible to structural failure due to less stringent quality control measures during the manufacturing process for these types of aircraft.
[33] Helicopters could suffer this result due to hydraulic lock and subsequent loss of control, if the helicopter was hovering in the wake of a wind turbine.

3.2.3 Wind Turbine Blade-tip Vortices

Wind turbine blades produce vortices downwind from the turbine. Pilots are well aware of the hazard of *wing tip* vortices, as wing tip vortices generated by large aircraft have caused a number of well-publicized fatal accidents.

A wind turbine blade generates aerodynamic lift in the same way that an aircraft wing does, by creating a region of lower air pressure above it. Fluids flow from high to low pressure, so the pressure differential between the top and bottom of the turbine blade causes some of the air flowing below the wing to migrate toward the top of the wing via the wingtips. When air flows from below the wing and out around the tip to the top of the wing, it does so in a circular fashion, creating a vortex.

Vortices create additional drag on a wind turbine blade, called Lift Induced Drag. Vortices also create undesirable noise, leading wind turbine designers to purposely restrict blade rotation speed to keep noise at an acceptable level. Because they are noisy and inefficient, engineers try to reduce wing tip vortices to the greatest extent possible.

The strength of vortices created by a wing is heavily dependent on the shape of the wing and the force exerted by the wing on the air. Wings with high aspect ratios create weaker vortices, and thus are more efficient, than wings with low aspect ratios[34].

Table 3.1 shows the relative magnitude of vortex circulation resulting from wind turbine blades and from aircraft of various sizes. This table shows that the vortices caused by wind turbines are not strong enough to pose significant risk to GA aircraft.

Table 3.1 : Vortex Circulation Comparison[35]

Example	Vortex Circulation
Cessna 172R	3.1
93m Turbine	5.4
Boeing 737	26.0
Boeing 747-400 (@ 156 Kts.)	83.0

The reasons that the relatively large "wing" used in wind turbines creates a relatively weak vortex are that they have very high aspect-ratios to maximize their efficiency, and because they exert relatively small forces on the air that passes over them[36].

Vortices probably do not exist past three rotor diameters outside of laboratory conditions. Figure 3.2 shows vortices created in a wind turbine in a wind tunnel experiment. This turbine is not removing energy from the wind, and hence is generating nearly no turbulence. In this instance, the vortices can be seen to extend for several rotor diameters behind the turbine. Figure 3.3 shows vortices emanating from the blade tips of a power-generating turbine in the atmosphere. In this case, it can be seen that the vortices exist for only a brief period immediately behind the rotor before they are destroyed by the turbulence created by the rotor.

Winds of high velocity will generate strong vortices. However, the vortices will be broken up more quickly by the higher wind speed, and by the turbulence that normally exists on windy days.

[34] An example of an airplane with a high-aspect ratio is a glider. These contrast with the wings of a CF-18 Hornet, have comparatively low aspect ratio.

[35] Ralph Holland, B Sc., Dip Ed., Dip. Com. Sc., ACT Australia. PowerPoint, n.t., Nov 2009. These numbers are based on a mathematical calculation related to such factors as: wing span, lift, speed, etc.

[36] Compared to the forces exerted on the air from a Boeing 747, for example.

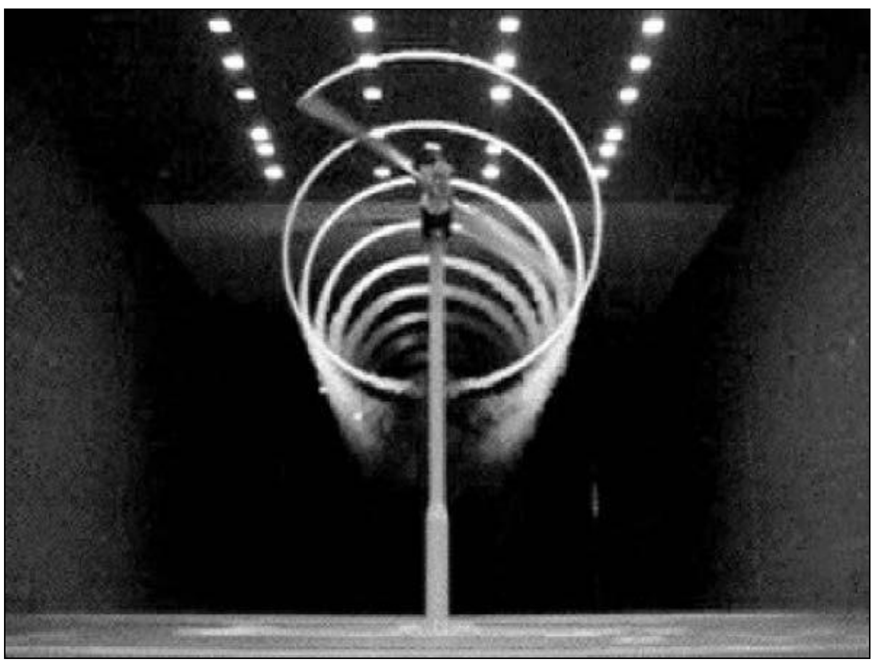
Exposure to vortices is expected to be greatest for small, light aircraft travelling at slow airspeeds within very close proximity of a wind turbine (e.g., less than 3 rotor diameters). The panel concluded that the effect of the vortices will be insignificant in comparison to the risks related to the overall turbulence generated by the wind turbine.

Turbine blade tip vortices form a part of a system of air-disturbance on the leeward side of a wind turbine rotor. While it is difficult to measure accurately the size and strength of vortices, it is known that overall turbulence behind the rotor is much stronger than the strength of the vortices, and that vortices do not exist without turbulence under normal operating conditions. Thus, because vortices are a weak component of the turbulence of the rotor, the risks associated with vortices are subsumed under the discussion of risks related to turbulence in Section 3.2.2.

Because vortices are heavily dependent on wing design, there are technical forms of mitigation available to reduce their magnitude. For example, the panel was informed that some wind turbine manufacturers are examining the use of winglets on the end of turbine rotor blades, similar to those found on modern passenger airliners. Winglets reduce the strength of vortices, thus increasing the efficiency of the wings or turbine blades.

Because of the very low aviation safety-risks associated with turbine blade tip vortices to GA aircraft, the panel could not endorse these technical initiatives as mitigation.

Figure 3.2 – Vortices in a Wind Tunnel[37]



[37] Source: Hand et al., NREL, 2002.

Figure 3.3 – Vortices from a Functioning Wind Turbine[38]

3.2.4 Wind Shear Caused by Wind Turbines

Wind turbines reduce the wind speed in the air mass immediately downwind of the turbine, creating what is called in aviation, 'wind shear'.

Wind turbines convert wind energy into electrical energy. Energy in wind exists in several forms, including kinetic energy – the mass of the air moving with a certain velocity. Since the mass of air passing through a wind turbine does not change, and some energy is removed to create electricity, the velocity of the air is reduced[39]. The reduction in wind speed behind a turbine is greatest when the turbine is extracting maximum power from the wind.

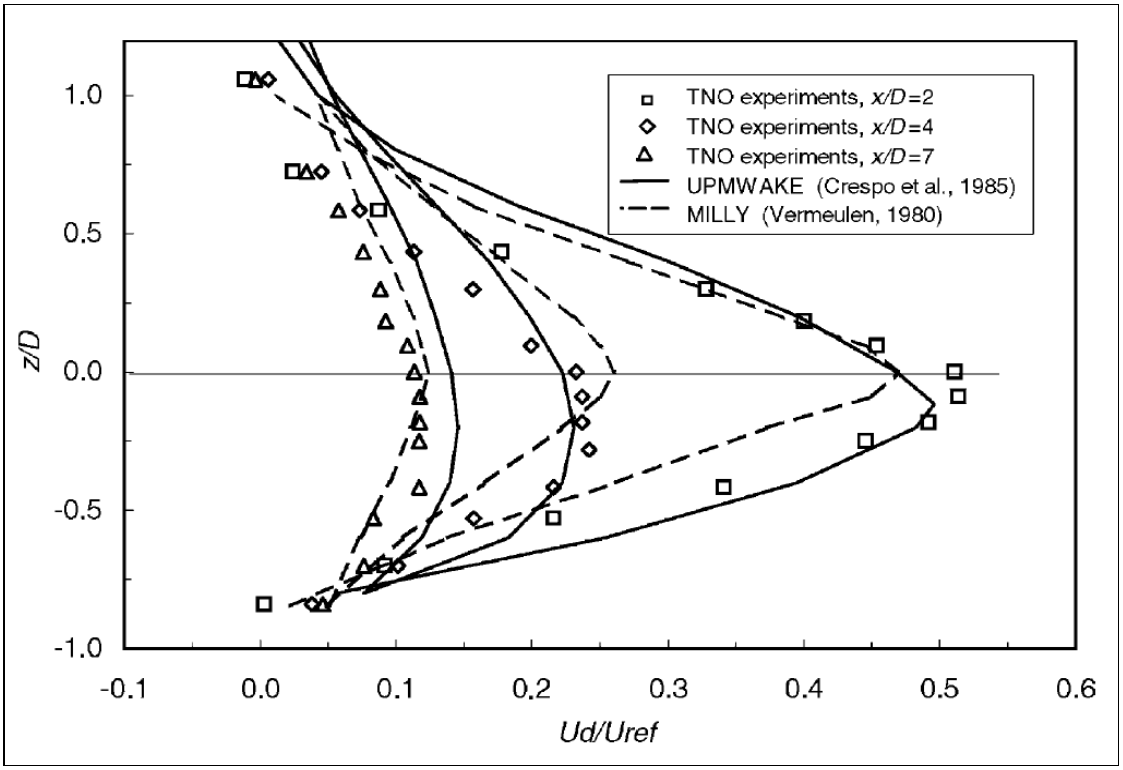
Because of their size, the stationary components of wind turbines can also reduce the downwind wind speed by obstructing wind flow. The steel pylon which supports the generator can be up to 100 m tall, and up to approximately 5 m in diameter at its base. The nacelle and generator assembly often weigh more than 95 tons.

Figure 3.2 depicts the magnitude of the decrease in wind speed as a factor of proximity to the turbine. The horizontal line (labelled 0.0) in the center of the chart equates to a line drawn horizontally through the hub of the turbine. The uppermost and lowermost horizontal lines (labelled 1.0 and -1.0, respectively) equate to the upper and lower reach of the turbine's blades. The decrease in wind speed increases as you move to the right along the horizontal center line. The different marker-shapes indicate different distances from the turbine rotor. For example, from the diagram it is shown that there is a 50 % reduction in wind speed at the middle of the turbine at a distance of 2 rotor diameters behind the rotor (square marker, x/D = 2). At a distance of 7 rotor diameters (triangular marker, x/D = 7), the reduction in wind speed at the center of the rotor is 10 %. At all distances, the reduction in wind speed near the tips of the rotor blades is nearly zero percent.

[38] Source: Technical University of Denmark, 2008.

[39] This is the result of the the first law of thermodynamics, also known as the law of conservation of energy, which states that energy cannot be created or destroyed.

Figure 3.2 - Wind Speed as a Function of Distance from Turbine Rotor[40]



At high altitudes, pilots sometimes experience wind shear in the vicinity of the jet stream, causing an abrupt shaking of the aircraft. Pilots sometimes encounter wind shear on arrival or departure at some airports, when the wind changes abruptly in speed and direction (i.e., velocity) from a headwind to a tailwind. The panel determined that wind shear created by a wind turbine will feel more like the former. They came to this conclusion because behind a wind turbine, although the average speed of the wind may be lower than the free-stream air, pilots will experience only chaotic, turbulent air flow.

Aircraft will be most affected by wind shear if they are flown within three rotor diameters of the turbine rotor[41]. If a plane were "crabbing" (due to a crosswind) when it flew behind a wind turbine, the slower wind behind the turbine could, at least theoretically, cause the plane to change heading. This could cause concern to the unsuspecting pilot of an aircraft on final approach for a crosswind landing, or immediately after lift-off. The wind shear would be most severe in strong winds, which is also the time when a plane would be near its crosswind limits. It would be difficult for pilots to predict when and where they would experience the wind shear effects, because the area of wind shear changes as the wind turbines rotate to face into the wind.

[40] Source: Vermeer et al, 2003.

[41] At further distances than this, pilots are expected to feel only turbulent air – the drop in wind speed will be indistinguishable from the general turbulence.

It was determined that without additional mitigation, the risks related to wind turbine generated wind shear are:

- UCFIT, which might occur to a pilot flying very near turbines at a speed close to the aircraft's minimum controllable speed[42], which was judged to have a remote chance of occurring (A-4);
- Pilots being forced to change course and fly around wind farms to avoid the effects of wind shear, expected to occur occasionally (D-1); and
- Pilots being forced to divert from an unusable aerodrome, judged to have a remote chance of occurring (D-3).

Like turbulence, the strength of wind shear decreases as distance from the turbine increases. Thus the risks to GA aircraft can be reduced by ensuring that there is sufficient distance between the turbine and the aircraft when the aircraft is at or below the height of the turbine rotor. For this reason, the mitigation for wind turbine induced wind shear is similar to the mitigation for wind turbine induced turbulence.

For aircraft during take-off and landing, the panel concluded that the same seven to ten rotor diameter setback from runways used to mitigate turbulence would be adequate to mitigate the risks of wind shear. To reduce the risks to en-route aircraft, the panel believed the most appropriate mitigation to be pilot education on wind shear caused by wind turbines, and judging safe distances from wind turbines. .

3.2.5 Interference with Signals generated by VOR Navigation Aids

Wind turbines can cause multipath interference, which can result in out-of tolerance conditions for Very High Frequency Omnidirectional Range (VOR) navigation aids.

VORs communicate with aircraft using signals transmitted at frequencies in the official range of 108.10 to 117.95 MHz. Aircraft receive the signals, which are processed to identify the plane's bearing. Pilots use this information to navigate along an IFR airway.

Multipath interference is a phenomenon whereby a wave from a source (in this case, the VOR) travels to a detector via two or more paths. Because each of the paths is a different length, the components of the wave interfere when they are received.

Interference can occur to varying degrees when any tall object (a building, mountain, wind turbine, etc.) is located in close proximity to a VOR station. It is the tall steel tower that supports the wind turbine which causes the greatest impact on VOR signals. The number and size of the wind turbines, their construction (shape and construction material) and their proximity to the navigation aid will determine the degree of interference.

The quality of the signal from the VOR also impacts VOR performance. The performance of VOR facilities is variable, and some stations operate with minimal margin for disturbance. Others, like Doppler VOR stations, can tolerate more potential sources of interference without going out of specification.

Although VORs are installed, operated and certified for IFR navigation on published Airways, it is a well-known practice for VFR pilots to employ a VOR radial to aid them in navigating, particularly in remote locations. Pilots are more likely to rely on a VOR radial in deteriorating visibility, or while flying

[42] It was judged that ultralights and smaller planes will be more susceptible to this effect. Pilots of ultralights also have less experience, less training, as a general rule.

in low ambient light conditions. Multipath interference might adversely affect the VOR radial being flown by the VFR pilot, causing the pilot to unknowingly wander from the intended flight path.

The panel judged the risks related to disruption of VOR signals to be:

- Collisions with obstacles (terrain in mountainous regions, or tall towers in western Canada, for example) due to being off course in conditions of marginal visibility, judged to be extremely improbable (A-5);
- Pilots becoming lost and their aircraft running out of fuel due to erroneous VOR signals in conditions of marginal visibility or locations with few landmarks, judged to be extremely improbable (A-5); and
- The imposition of non-preferred route structure by the air navigation service provider to avoid negative effects of wind turbines on VOR, judged to have a remote chance of occurring[43] (D-3).

One of the steps involved in the approval process prior to a new wind farm being constructed is an assessment of the effects of the proposed wind farm on NAV CANADA equipment, such as VORs and radar. In its evaluation, NAV CANADA identifies whether the proposed development is acceptable from their point of view, and identifies mitigation that can be taken to ensure that the effects of the development on NAV CANADA equipment are within an acceptable limit.

In Alberta, the provincial government will only authorize a wind farm proposal after NAV CANADA has confirmed that it will have no-effect on this equipment. Other provinces require that NAV CANADA assess wind farm proposals, but do not require that NAV CANADA approve proposals prior to authorizing them. Still other provinces do not include NAV CANADA in the government assessment process.

Terrain can play a role in reducing the effects that a wind farm has on a VOR. Hilly terrain between the navigation aid and the wind farm can reduce the magnitude of interference with VOR signals. Because turbine siting and construction can reduce the impact of wind turbines on VOR, the panel discussed educating developers on the effects that turbines can have on VOR, and on how to select and site turbines in ways that reduce the impact of their projects on VORs.

The panel felt that it was important to educate pilots that wind turbines may make VOR less accurate. This would further reinforce the existing rules around having alternative means of navigation.

3.3 Impact of Wind Turbines on Helicopters

Helicopters are exposed to most of the hazards listed in the previous section. However, helicopters are not affected in the same way or to the same extent as airplanes.

Since most helicopters operate between ground level and 2000 ft. AGL, wind turbines are obstacles that helicopter pilots regularly encounter. Because helicopter pilots have more flexibility in choosing the locations from which they take-off and land, turbines – as obstacles − pose less risk than they do for fixed-wing GA aircraft during these phases of flight. Because helicopters are more likely than GA aircraft[44] to cruise at altitudes which could cause them to encounter wind turbines en-route, wind turbines – as obstacles – pose more risk en-route than they do for fixed-wing aircraft.

[43] Panel members were aware that this has in fact occurred in some jurisdictions in the United States due to wind farms.
[44] Aerial applicators and ultralights are two examples of exceptions to this general rule.

Most low-level helicopter operations, during which helicopters may be expected to encounter wind turbines, take place when pilots encounter conditions of reduced visibility[45]. In these instances, helicopter pilots reduce air speed (to between 0 and 60 Kts) so that they can see and avoid obstacles. While lower airspeed makes it easier for pilots to avoid obstacles, conditions of reduced visibility may make wind turbines (and in particular their rotating blades) more difficult for helicopter pilots to see.

The risks related to turbines as obstacles to low-flying helicopters are somewhat mitigated by the typical placement of wind farms. As discussed in Section 2.1, wind turbines are normally constructed close to the demand for electricity, or close to where there is grid capacity to transport the electricity. As such, wind farms are more likely to be constructed in densely populated regions of Canada. Because many helicopter operations take place in more remote areas and not in densely populated regions, their exposure to wind turbines as obstacles or turbulence generators will be reduced.

At cruise speeds, helicopters (i.e. rotary-wing aircraft) are not as susceptible to turbulence as airplanes (i.e., fixed-wing aircraft). Therefore, an encounter with wind turbine generated turbulence en-route will not pose as much risk. However, helicopters are particularly sensitive to turbulence when hovering, at which time the turbulence can cause a temporary loss of control.

Helicopters must hover when landing or taking off. Setback distances from helipads similar to those discussed in Section 3.2.2 for aerodromes would mitigate the negative effects of turbulence during these phases of flight. When landing at a site other than a prepared helipad, or planning an operation in which hovering is involved (e.g., long-lining), the panel believed that pilots should seek prior information on the location of wind turbines. In cases where helicopters are used to transport maintenance crews to and from wind turbines, consideration should be given to stopping turbine blade rotation while the helicopter is operating in the area.

3.4 Summary

The safety-risks associated with GA aircraft operating in very close proximity to wind turbines – in particular, light and ultra-light aircraft − during take-off and landings from aerodromes, are assessed to be from low to moderate significance. The remainder of the safety-risks to GA aircraft are assessed to be very low. The strategies to mitigate the hazards and risks are discussed more fully in Section 4.

[45] Reduced visibility in this case means visibility as low as 1 mile. In some instances, helicopter flying can be authorised in conditions with as little as 0.5 mile visibility.

4.1 Introduction

As noted in Section 3, the significance of the safety-risks posed by wind turbines to GA aircraft is assessed to be very low, with the exception of light and ultralight aircraft operating from aerodromes, in which case the significance is assessed as low to moderate. The assessment takes account of current forms of mitigation, examples of which include:

- Lighting standards for tall structures published by Transport Canada[46];
- Standards in TP312 and TP1247E regarding minimum setback distances for tall objects from airports;
- Land development processes that enable the impact of proposed wind farm developments on NAV CANADA's air navigation services;
- Air navigation charts that show the locations of wind farms; and
- The Canadian Air Regulations (CARs) Part 602 which amongst other things presents the visual flight rules that govern most operations of GA aircraft (including minimum ceilings and flight visibilities).

The panel recognized that as the number of wind farms grows, GA aircraft will be increasingly exposed to wind turbines as hazards to aviation.

Section 4.2 describes additional mitigation that the expert panel considered necessary to address current hazards and risks. Section 5 discusses actions that can be taken to ensure that mitigation keeps pace with technological advancements in both the aviation and wind energy industries so that the associated risks can be maintained at an acceptable level.

4.2 Mitigation

4.2.1 Education Programs

Exposure to the aviation hazards of wind turbines can be reduced by improving knowledge of the associated risks. This concerted education program should target all participants of the system, and in particular pilots.

Many of the existing forms of mitigation aim to ensure pilots know the location of wind turbines. However, the panel felt strongly that the general understanding of pilots and wind developers of the effects of wind turbines on aircraft was low.

For new pilots, flight school curricula should be updated to teach the risks of flying near wind turbines. Topics could include technical descriptions of the hazards and risks of wind turbines, guidelines for flying near wind turbines, how to interpret wind farm lighting, warnings of particularly hazardous circumstances, etc[47]. This training could be tailored to the risks related to the category of aircraft that the students are being trained to fly (e.g. light aircraft, ultralight aircraft, helicopters, etc.).

For current GA aircraft and helicopter pilots, similar information should be disseminated through a variety of channels. Such media could include Transport Canada aviation safety newsletters, videos

[46] Transport Canada is in the process of updating the requirements for marking and lighting wind turbines.

[47] Some of these topics may already be included in the curricula of some flight schools and colleges.

and safety posters, industry safety briefings, company-specific safety meetings and training sessions, association newsletters and a revision to the Canada Flight Supplement.

For wind developers, an industry awareness program on the effects of wind turbines on aircraft is warranted. The training could include the technical and safety effects of wind turbines on different components of the aviation system, and provide guidance on how to modify wind turbine siting, wind turbine selection, etc., to reduce aviation safety-risks.

4.2.2 Minimum Setback Distance Standards

As mentioned in Section 4.1, Transport Canada's TP312, *Aerodrome Standards and Recommended Practices*, defines the obstruction limitation surfaces around certified airports which restrict the building of tall structures near airports. These limitation surface standards do not apply to non-certified aerodromes, and there are no regulatory criteria that prevent wind farms from being developed in close proximity to either registered or non-registered aerodromes.

As discussed in Sections 3.2.1 through 3.2.4, GA aircraft are most exposed to risks relating to wind turbines when aircraft fly at or below the height of wind turbines – most often during take-off and landing.

The panel determined that to reduce the risk to GA aircraft when operating from non-certified aerodromes, an adapted form of obstacle limitation surfaces should exist. This could be achieved through regulatory standard or policy. Based on the available information, the panel determined that the following criteria would be appropriate:

- An area extending 2.5 km from both ends and at least one side of the aerodrome's runway in which there are no obstacles higher than 45 m[48];
- A restriction on constructing wind turbines within 7-10 rotor diameters from the approach surfaces[49]; and
- The area of land under the aerodrome traffic pattern (or circuit) is free of wind turbines[50]. Non-standard circuits can be specified to minimize turbulence based on the prevailing wind direction, among other factors[51].

In some cases, the proposed setback distances would not be practical, for example, when wind turbines have already been constructed within 7 rotor diameters of a runway. In these situations, the panel felt that the risks associated with disrupted airflow due to wind turbines could be adequately mitigated through arrangements with wind farm operators to shut-down wind turbines in close proximity to the runways for specified periods. For example, this could be during particularly busy flying periods, such as Saturday mornings in the summer, or during scheduled flight school activities. While a possibility, the panel felt that this mitigation would likely be difficult to implement.

If formal legislation is not used to impose the above restrictions on wind farm development, the panel felt that the wind industry should be encouraged to update their already extensive consultation process to ensure that these topics are discussed with aerodrome operators who are potentially affected by proposed wind farm developments.

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[48] 45 m is the height restriction used in TP312.

[49] A distance of 7-10 rotor diameters should be maintained from the approach surfaces and the runway. For example, this would mean that wind turbine construction should be restricted within 2.5 km *plus* 7-10 rotor diameters from each end of a runway.

[50] Circuits are specified in CARs Part 602. Circuits are normally left-hand (i.e. require left-turns when in the circuit). Registered aerodromes can specify in the Canada Flight Supplement that either left or right circuits are to be used.

[51] To institute any non-standard circuit procedures (such as right hand traffic patterns or non-standard flight altitudes) the aerodrome must be registered with Transport Canada and approval must be sought from the Minister of Transport in accordance with Canadian Aviation Regulation 602.96 paragraph 3(C).

4.3 Special Operations

The panel noted that pilots carrying out special operations (e.g. police, search and rescue and military flights), are exposed to the effects of wind turbines, although the magnitude of this exposure is not known. The panel concluded that organizations involved in these operations would be responsible to take the necessary measures (e.g., develop standard operating procedures; specific safety campaigns, etc.) to mitigate the risks they expect to encounter.

Groups conducting special operations should be encouraged to review the findings of this report.

5. CONCLUSION AND OBSERVATIONS

5.1 Conclusion

It was determined that the safety significance of wind turbines on the Canadian Civil Aviation System as a whole is very low. However, the panel concluded that steps are necessary to further mitigate the risks faced by pilots flying GA aircraft. To maximise both the effectiveness of new mitigation strategies, they recommended that stakeholders from the wind energy and aviation industries – including regulatory bodies – coordinate their activities. This will encourage the development of a systematic approach to wind farm development across Canada, which in turn will streamline the development process, minimize the number of challenges received by both regulators and developers, and improve overall system safety.

5.2 Observations

5.2.1 General

The number of wind farms in Canada is expected to continue growing for the foreseeable future. Coupled with this growth are evolving technologies that enable wind farm developers to reach higher into the sky in order to capture the more constant wind found at increased elevations. In Europe, some developers have begun installing wind turbines similar to those described in Section 2.1 but reaching up to 200 m (656 ft.) in total height with rotors up to 136 m (442 ft.) in diameter. Newer technologies, such as helium-filled floating turbines suspended on 1000 ft. (305 m) cables[52], could exacerbate existing hazards, or impose new ones, on low-flying aircraft.

To adequately address these new challenges, new technologies will need to be promptly identified by the regulators of the aviation system, and their impact assessed to ensure that mitigation will remain robust. For this to happen, strong ties are needed between the groups involved with the regulation of the aviation industry and groups developing wind farms and wind technologies.

Recent activities in this regard are working well. NAV CANADA and CanWEA are to be commended for their work in 2010 to build a link between their respective communities. The aim of the joint working group established between these two organizations aims to improve understanding of each industry. Such an approach builds trust and cooperation, which is critical when dealing with sensitive technologies and concerns of intellectual property. . Other stakeholders should be encouraged to take a similar approach.

5.2.2 Integration of the Wind Farm Approval Process

As discussed in Section 2.2, wind farm proposals go through an extensive and time consuming review process prior to being approved. Approval processes are not consistent across Canada, as most of the approvals are at a provincial or municipal level. The purpose of the multifaceted approvals process is to ensure that the many (and sometimes conflicting) interests of the public – environmental impact, economic stimulus, protection of health and safety, etc. - receive balanced consideration.

At the same time, there is pressure from many groups, including wind developers and provincial governments, to ensure that wind energy projects proceed. This pressure escalates as each step in the review process is successfully completed, because each step requires significant investment of resources, and project delays mean delays in investment in local economies. The downside of this

[52] Source: Magenn.com

pressure is that it can encourage decision makers to ignore the concerns of potentially affected parties.

This situation establishes a potential system safety deficiency – conditions that permit hazards of a like nature to exist. The complexity of the approval processes and lack of integration across Canada makes it difficult to update requirements as the understanding of the effects of wind turbines evolve. Coupled with the pressure to complete wind projects, aviation safety hazards have the potential to go unidentified, and therefore unmitigated.

A national strategy is needed to address this situation. Common processes that influence local approval processes across Canada would benefit the growth of sustainable energy production.
The longer that the current disjointed situation is allowed to persist, the more time and money will be lost on flawed projects, or on arguing for the approval of sound projects. Worse than that, the greater will be the chances of projects realizing safety, environmental or health risks due to lack of integration of new knowledge.

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APPENDIX A: RISK ASSESSMENT PANEL MEMBERS AND OBSERVERS

PANEL LEADS

Panel Lead	Terry Kelly, SMS Aviation Safety Inc.
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Roger Constantine	Acting Chief, Aviation Safety Policy, Transport Canada
Bob Grant	Civil Aviation Inspector, AIS & Airspace Standards, Transport Canada

Environmental Registry # 012-0614
Ministry of the Environment Ref. # 8250-8XUKKC

Fairview Wind Project

Requesting Comments by 01 February 2014

Submission by Kevin & Gail Elwood
8257 County Rd 91, Stayner, ON

Appendix 4.3

THE PERILS OF WIND TURBINES

By COPA Director Paul Hayes

A matter of increasing concern to our members is the almost uncontrolled spread of wind turbines across many areas of our country with, in many cases, little or no concern for the impacts on aviation.

These structures, nominally over 400 feet in height above ground, are being established either individually, in small groups or in much larger farms of over twenty or more units. In virtually every instance, there is no requirement for the proponent or authorizing authority to carry out any form of an aeronautical assessment to ascertain the potential impacts on aviation resources or local flight operations, and yet the aviation safety impacts include obstacles in the vicinity of aerodromes, wake turbulence and the lack of effective aeronautical marking and lighting in accordance with the appropriate Canadian Air Regulations and Standards.

A particularly aggressive approach to wind turbines occurred in Ontario when the government established the Green Energy Act. Prior to the passage of the legislation, COPA appeared before the committee holding hearings and petitioned to have a requirement included in the Act that wind turbine proponents or approving authorities conduct an aeronautical study to assess the aviation impacts of a proposed development and to develop appropriate setbacks and other mitigating measures. COPA's petition was not accepted and the final version of the Act also removed the ability of municipalities and other lower forms of government from controlling the development of these types of clean energy projects in their backyards.

Local Aircraft Flight Pattern – An International Standard:

The typical traffic pattern (or circuit) flown by light aircraft when manoeuvring in the vicinity of aerodromes is to an international standard and pilots are expected to adhere to it when flying to and from these aerodromes. The prescribed standard pattern is normally left hand. This results in the pattern being both sides of the runways to allow for take-offs and landings in opposite directions. The normal dimensions of the pattern are 2 km off both ends of a runway and 2 km abeam the runway when in the downwind.

As a variation to the standard left hand turns in the pattern, at numerous aerodromes a right hand circuit is used under various circumstances to avoid such factors as obstacles and noise sensitive areas in the vicinity of an aerodrome. Where a circuit pattern using right hand turns is required, it must be specified in the CFS. This, of course, requires that the aerodrome is registered and therefore is listed by Transport Canada in the CFS. The appropriate provision for the use of right hand patterns or circuits is found in Canadian Air Regulation 602.96, paragraph (3) (c).

Of note is that frequently in wind turbine development proposals, proposed sites are inside the normal boundary of a traffic pattern at the aerodromes - that is, they would be between the normal downwind leg of the pattern when an aircraft would be flying abeam the runway, as well as inside the climb out and approach patterns. In this regard, the standard usually assumed is that, if possible, there should not be any tall obstacles between an aircraft flying in the circuit pattern and its access to the runway in the event of an urgent need for a landing. In the case of turbines located between the downwind, climb out and approach and the runway, this principle is violated, and it is therefore not a safe situation.

Transport Canada Position:

For some certified aerodromes (airports) that have registered zoning in effect in accordance with the provisions of the federal Aeronautics Act, the airspace around them is protected from penetration by such obstacles. For many other airports and all registered and unregistered aerodromes, there is no such protection. Any obstacle erected in the approach or departure paths or in the circuit at these aerodromes may result in the raising of IFR minimum approach altitudes and overshoot or departure restrictions, modifications to circuit procedures or even prohibition of the use of one or more runways. In the worst case scenario, Transport Canada could prohibit any aviation activity at the aerodrome.

It is important to emphasize that Transport Canada's only interest in wind turbines is that these obstacles are appropriately lit and in fact they have backed away from any marking requirements, which is why you only see white turbines in Canada. Protection of our aviation infrastructure from encroachment is not of interest to Transport Canada, other than to restrict operations when a wind turbine has been assessed as a safety issue.

Wind turbines pose an additional hazard compared with other obstacles because they produce wake turbulence that can extend a considerable distance downwind. Additional precautions are necessary compared with other obstacles such as antennas in order to avoid this silent killer. Although there has been some research into wind turbine turbulence, no setbacks have been established by regulation to ensure aviation safety in the vicinity of wind turbines.

Determining setbacks

The only TC guidance is contained in the certification requirements for certified aerodromes. As a suggested guideline in trying to provide an adequate level of obstruction clearance, Transport Canada refers proponents to use the obstacle limitation surfaces for a Code 1 non-instrument runway that are outlined in Transport Canada document TP 312 Aerodrome Standards and Recommended Practices, Chapter 4, paragraph 4.2.2 and Table 4.1. The standard that can be most specifically applied is the take-off approach surface as the principle obstacle clearance criterion.

This surface is 2,500 meters long and diverges at 10 percent from the ends of the runway strip. At its outer limit, the surface is 560 m wide, and at the specified 1:20 slope, it would be 125 m above the elevation of the end of the runway.

In using just the 2,500 m long take-off/approach surface and the specified 1:20 slope, the height above ground at the outer limit of this surface would be 125 m or 410 feet. In addition, looking at this from the perspective of aircraft performance, and using a representative climb or descent angle of 3 degrees and a speed range of 70 to 90 miles per hour, aircraft might typically be expected to be in the order of 400 to 500 feet above ground at the 2,500 m outer end of the approach surface. When allowance is made for the effects of aerodrome altitude and air temperature during summer operations, the altitudes attained in the climb will be expected to be not as great – for example, with reference to the Koch chart in the planning section of the CFS, based on an aerodrome elevation of about 1,500 feet above sea level and a typical summer day temperature of 30 degrees C, the rate of climb for an aircraft may be reduced by in the order of 35 percent, so that the 400 to 500 feet above ground of the height of a representative turbine at the 2,500 m point would not be reached. As the wind turbines could be in the order of at least 400 feet in height, it is concluded that the 2,500 m distance alone would not provide sufficient safety protection if a turbine were to be located in the vicinity of the end of the take-off/approach surface. As well, the effects of the wake and turbulence from a turbine if the wind is blowing toward the runway would be most pronounced on an aircraft just at this height.

For the above calculations, the Cessna 150 and 172 types, as well as the Aeronca Champ and Piper J3 Cub, have been used as representative aircraft types. However, as mentioned above, ultralight aircraft are also operated at many of the aerodromes. These aircraft, which are much lighter, typically climb after takeoff and descend for landing at a steeper angle. Because they are lighter and often climb and cruise at lower airspeeds it is understood that there may be potential for controllability issues in turbulent conditions. The matter of the wake turbulence from the wind turbines could therefore be of more concern with these aircraft.

If the TP 312 standard for the outer surface is included in the consideration, then any obstacle higher than 45 m (150 feet) above the elevation of the aerodrome within a 4 km radius of the aerodrome centre point would not be acceptable. This surface is intended to protect aircraft maneuvering in the vicinity of an aerodrome. However, to test if even the 4 km distance from the ends of a runway would provide adequate safety protection, an assessment was completed based on aircraft performance characteristics, suitable minimum obstacle clearance of at least 300 feet above the top of the turbines, and the possible wake and turbulence effects of the turbines. Using the same 70 to 90 mph light aircraft climb speed and the associated 300 to 400 feet per nautical mile (160 to 215 ft/km) climb gradient, the representative aircraft would be expected to be in the order of 700 to 850 feet above ground at the 4 km point. This should place the aircraft at least 300 feet above the top of a 400 foot high wind turbine, most likely to avoid the effects of the expected wake and turbulence. From this analysis, it might be concluded that at 4 km from the runway ends and along the extended runway centre line there would be adequate clearance.

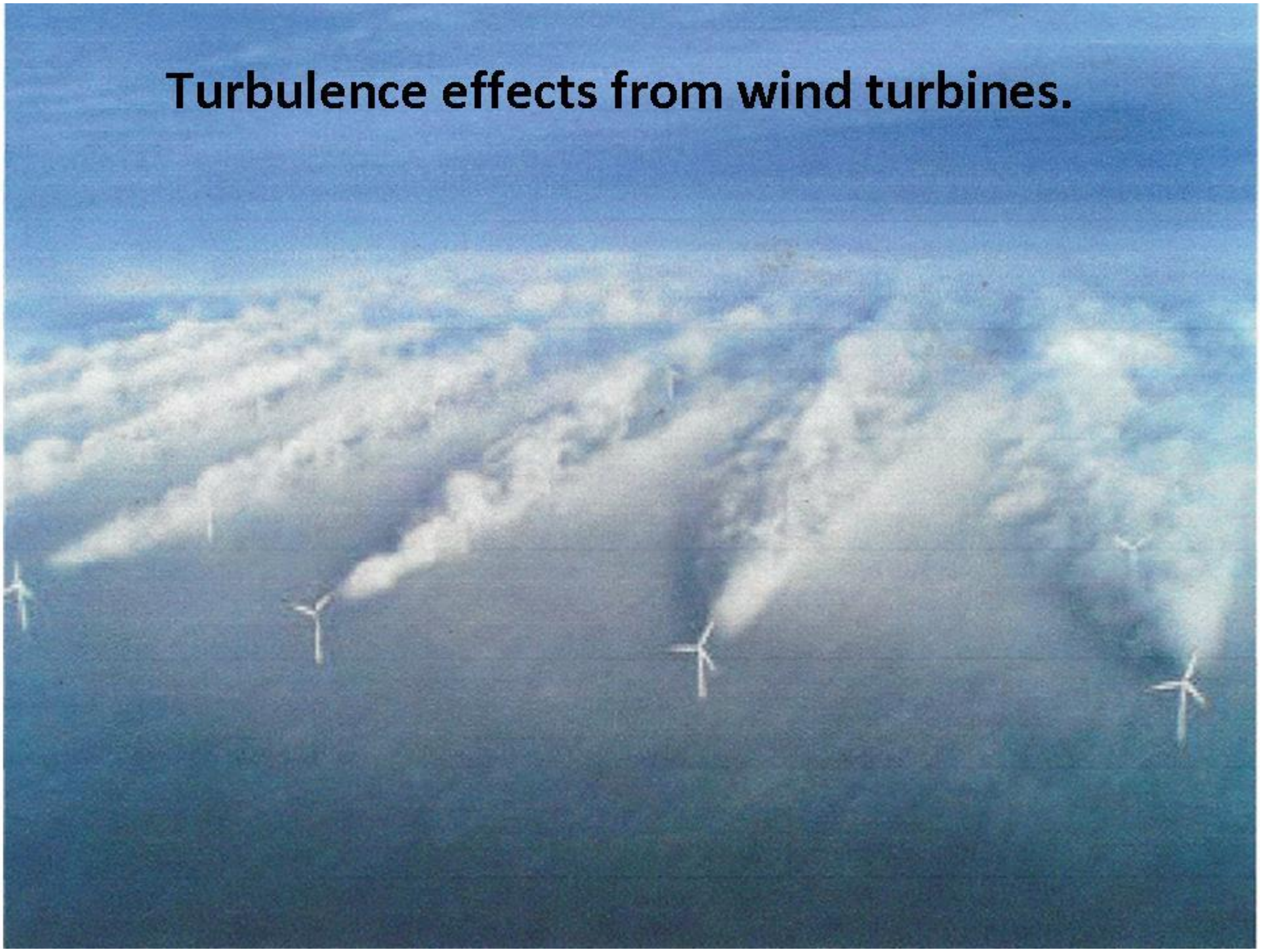
Information on the potential effects on aircraft of wake turbulence generated by wind turbines is quite variable. Some information suggests that at three rotor diameters behind a turbine the turbulence may be largely dissipated, while other sources suggest it may still occur at a greater distance, as much as ten rotor diameters or more. Information available to us suggests that wind turbine companies may generally rely on a downwind distance of five rotor diameters in setting up the spacing between individual turbines so as to avoid the effects of wake turbulence on adjacent turbines. This standard can be applied in suggesting how far a turbine should be from a low level aircraft flight path.

For example, using a five rotor diameter downwind allowance and a nominal rotor diameter of 100 m, this would mean a separation distance of at least 500 m. This would suggest that no turbine should located any closer than 500 m outside the 2 km outer boundary of the aerodrome air traffic or circuit pattern.

COPA’s work in protecting aerodromes from Wind Turbine interference

In addition to COPA’s efforts to convince the Ontario government to consider the effects of wind turbines on aviation when the Green Energy Act was developed and attempts to engage Transport Canada in developing standards to minimize the safety impact on aerodromes, COPA's Freedom to Fly Fund is being employed to investigate legal aspects to determine if there is some basis to prevent encroachment on aerodromes or provide compensation for the loss of use. Our recent win at the Supreme Court level on federal jurisdiction is being examined to see if it is applicable to wind turbine encroachment on aerodromes. The Fund is also being used to conduct a formal safety risk assessment, in which the wind generation industry, the governments and others will be invited to participate. The end point of this exercise will be to determine the safety risks associated with wind turbines and develop risk mitigation measures that can be employed, either voluntarily or by regulation, to minimize the risks and continue aerodrome operation.

Until a firm direction is established, members whose aerodromes are being impacted by wind turbine installations are advised to get involved early in the development process to make your concerns known. You can use the calculations from this article to point out the safety issues and encourage the proponents to minimize their liability by keeping the turbines a suitable distance away from the approach, departure and circuit areas.


Turbulence effects from wind turbines.