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Aviation Impact Assessment

TOBIN Consulting Engineers

Castlebanny Wind Farm

December, 2020





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ADMINISTRATION PAGE

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Issue	Date	Detail of Changes
1	June, 2020	Initial issue (10027A) conducted by Michael Sutton
1	October, 2020	Initial issue (10027B) conducted by Danny Scrivener Updated to consider new runway threshold co-ordinates
2	November, 2020	Update regarding Instrument Flight Procedures
3	December, 2020	Minor amendments – review by Kai Frolic

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KEY FINDINGS

Background

Pager Power has conducted an aviation risk assessment for the proposed Castlebanny Wind Farm located southeast of Ballyhale, Ireland, to determine its impact upon aviation activity associated with Waterford Airport.

This assessment has considered the impact upon the Obstacle Limitation Surfaces (OLS), Instrument Flight Procedures (IFPs) and consideration of a possible runway extension at Waterford Airport.

The Proposed Development

The proposed development has been assessed based on a maximum wind turbine tip height of 185m above ground level (agl).

Overall Conclusions and Recommendations

The proposed wind farm is unlikely to have a significant impact upon the existing aviation activity associated with Waterford Airport. The wind farm is outside of the OLS, including consideration of the new runway. No current IFPs are expected to be affected.

Calculations show that the proposed 2,000ft DME 12nm IFP is not possible in its current form as vertical clearance would not be maintained considering an existing wind farm in close proximity to the 12nm arc. This IFP would therefore have to be re-considered and in doing so, steps could be taken to accommodate the proposed wind farm. Consultation with Waterford Airport is recommended on this point.

Technical Findings

Obstacle Limitation Surfaces

The proposed wind development does not infringe any of Waterford Airport's Obstacle Limitation Surfaces. This conclusion remains the same considering the proposed larger runway. No impacts are therefore predicted.

Instrument Flight Procedures

All high-level assessments have shown that the clearance distances between the assessed procedures and the proposed turbines exceed all relevant clearance minima.

With respect to new IFPs as a result of the runway extension, a 2,000ft DME 12nm arc has been assessed. Considering an existing wind farm, a 1,000ft clearance would not be possible. Therefore the minimum altitude would need to be increased, in doing so, steps could be taken to accommodate the proposed wind farm to ensure minimum clearance distances.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 48 countries within Europe, Africa, America, Asia and Australasia.
The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects.
- Building developments.
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

1 INTRODUCTION

1.1 Overview

Pager Power has conducted an aviation risk assessment for the proposed Castlebanny Wind Farm located southeast of Ballyhale, Ireland, to determine its impact upon aviation activity associated with Waterford Airport. The proposed development has been assessed based on a wind turbine tip height of 185m above ground level (agl).

The initial report (10027A) considered the existing runway dimensions as per the Irish Aviation Authority (IAA) Aeronautical Information Publication (AIP). This report (10027B) considers new runway threshold co-ordinates, identified through consultation with Waterford Airport, due to a planned increase in runway length. Technical updates considering the increased runway dimensions have therefore been completed throughout this report.

The report includes the following:

- Identification of relevant aviation infrastructure;
- Overview of relevant safeguarding assessment distances;
- Obstacle Limitation Surfaces assessment;
- High-level Instrument Flight Analysis assessment, including:
    - Instrument Flight Procedures;
    - Minimum Safe Levels.
- Overall risk and key issues.

The aim is to identify and assess the aviation risks associated with achieving planning permission and construction of the proposed wind development.

2 PROPOSED DEVELOPMENT INFORMATION

2.1 Wind Turbine Details

The turbine details used in the assessment are as follows:

- Tip height: 185m;
- Rotor diameter: 155m.

The maximum altitude of the highest turbine (T6) is 441.3m/1,447.8ft above mean sea level (amsl).

2.2 Wind Turbine Layout

The wind turbine layout has been assessed within this report as provided by the developer. The co-ordinates of the turbine locations are shown in Table 1 below. The co-ordinates are presented in WGS84 longitude and latitude and also Irish Transverse Mercator Easting and Northing format.

ID	Longitude	Latitude	Easting	Northing	Maximum altitude (land height plus turbine height)	
					m	ft
T1	-7.14072	52.40853	658464.1	628904.1	394.8	1,295.3
T2	-7.12596	52.4162	659457.9	629770.2	433.8	1,423.2
T3	-7.13744	52.41566	658677.5	629700.7	403.2	1,322.8
T4	-7.12745	52.42138	659349.4	630344.9	438.2	1,437.7
T5	-7.14031	52.42132	658474.9	630327.9	383.2	1,257.2
T6	-7.12819	52.42701	659291.8	630970.6	441.3	1,447.8
T7	-7.14043	52.42625	658460.3	630875.9	390.0	1,279.5
T8	-7.13315	52.43146	658948	631462.1	422.4	1,385.8
T9	-7.14534	52.43062	658120.2	631358.7	369.2	1211.3
T10	-7.13789	52.43596	658620.1	631958.2	402.9	1321.9
T11	-7.15064	52.43488	657754.4	631827.8	365.9	1200.5

ID	Longitude	Latitude	Easting	Northing	Maximum altitude (land height plus turbine height)	
					m	ft
T12	-7.14133	52.44047	658380	632457.3	407.6	1337.3
T13	-7.15244	52.4404	657624.7	632440.5	379.0	1243.4
T14	-7.13927	52.44652	658511.9	633132.2	420.9	1380.9
T15	-7.15141	52.44615	657687.2	633081.1	398.9	1308.7
T16	-7.14055	52.45157	658418.4	633692.8	429.0	1407.5
T17	-7.15302	52.45132	657571.1	633654.6	413.4	1356.3
T18	-7.14506	52.45721	658104.6	634316.5	418.3	1372.4
T19	-7.1569	52.45506	657302.6	634068.7	410.4	1346.5
T20	-7.14946	52.46142	657799.8	634781.4	409.3	1342.8
T21	-7.1609	52.45933	657025.2	634540.6	367.7	1206.4

Table 1 *Turbine co-ordinates*

The locations of the assessed wind turbines are shown in Figure 1[1] on the following page.

[1] Source: Aerial imagery copyright © 2020 Google.

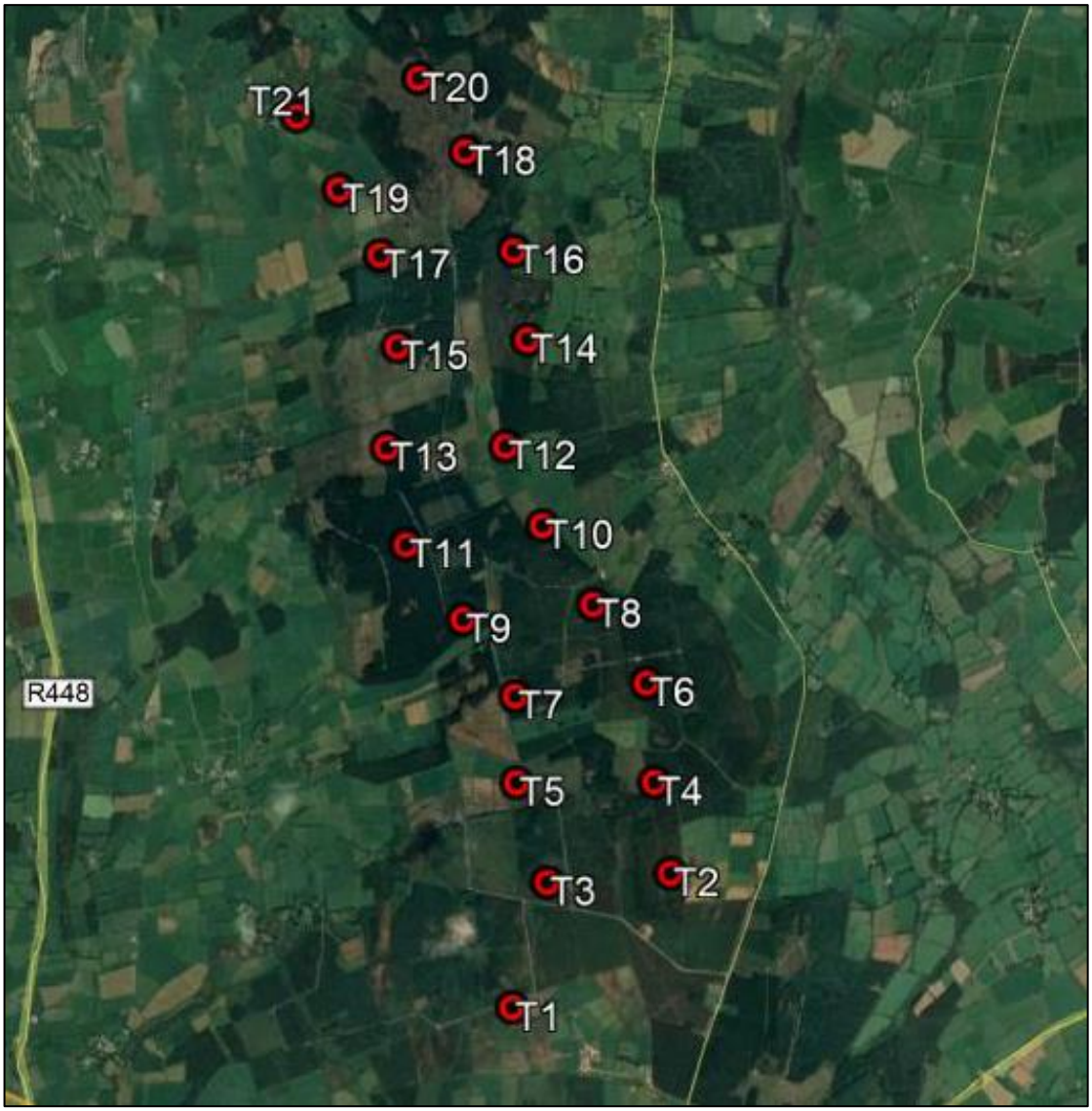

Figure 1 *Proposed wind farm layout*

3 OBSTACLE LIMITATION SURFACE ASSESSMENT

3.1 Overview

Obstacle Limitation Surfaces (OLS) are imaginary surfaces defined in three dimensions for physical safeguarding purposes (i.e. ensuring that physical structures do not present a safety hazard at an airfield) and are defined around licensed airfields.

An assessment of both the existing runway and a potential future larger runway are presented within this section.

3.2 Waterford Airport's Obstacle Limitation Surfaces

The runway threshold co-ordinates used as a basis for the OLS assessment are presented in Table 2 below. The data is taken from the IAA Aeronautical Information Publication (AIP). Co-ordinates are presented in both decimal degree and degrees, minutes and seconds format (as per the AIP).

Runway Threshold	Longitude	Latitude	Altitude	Comments
THR 03	-7.0902472 0070524.89W	52.1819389 521054.98N	86ft 26.2m	Displaced 90m
THR 21	-7.0839556 70502.24W	52.1920111 521131.24N	113ft 34.4m	Displaced 143m

Table 2 *Runway threshold data used for the OLS assessment*

The OLS for Waterford Airport have been modelled with respect to the proposed wind development and are shown in Figure 2 on the following page – the x and y axis show the longitude and latitude respectively, the red crosses denote the turbines and the OLS is illustrated in 2D. The dimensions and geometry of the surfaces are constructed based on detailed rules defined in the ICAO Annex 14.

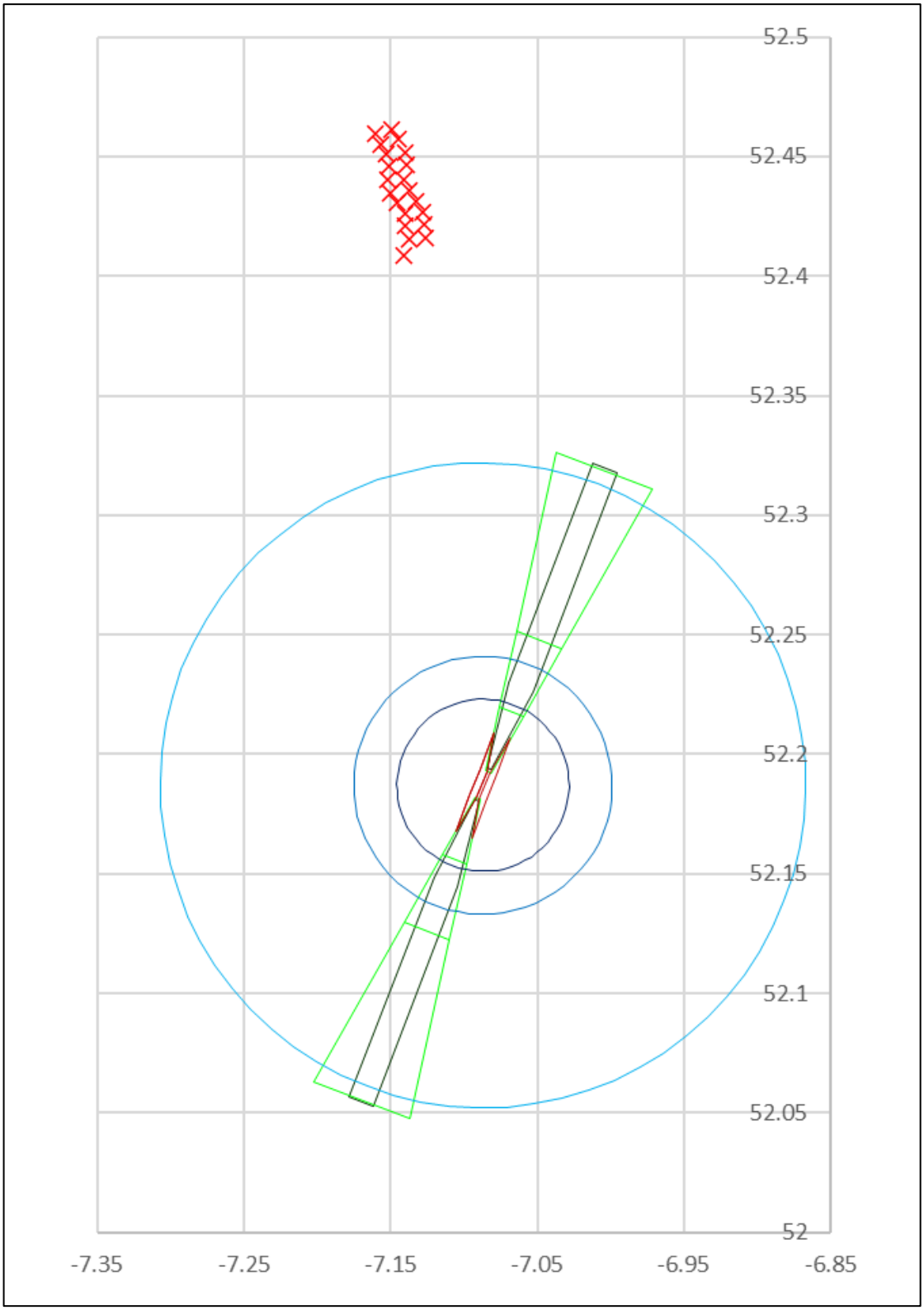

Figure 2 *Waterford Obstacle Limitation Surfaces*

3.2.1 Obstacle Limitation Surfaces Results

The analysis has shown that the proposed wind development does not infringe any of the Waterford Airport's Obstacle Limitation Surfaces because it is well beyond to the limits to which they extend. No impacts are therefore predicted for the existing runway.

3.3 New Runway 21 Threshold Co-Ordinates

Waterford Airport have indicated that the runway maybe extended. This would involve relocating the runway 21 threshold further north[2] by approximately 480m. This may have implications on the OLS assessment for the proposed wind farm. The details for the proposed runway 21 threshold are presented in Table 3 below.

Runway Threshold	Longitude	Latitude	Altitude	Comments
New THR 21	-7.0814194 7 ° 4'53.11" W	52.1960694 52° 11'45.85" N	131.7ft 40.14m	None

Table 3 *Runway threshold data used for the OLS assessment*

The threshold co-ordinates locations are shown in Figure 3[3] below.

Figure 3 *Runway 21 existing and proposed threshold co-ordinates*

The OLS for Waterford Airport considering the extended runway[4] have been modelled. The chart is shown in Figure 4 on the following page.

[2] Not including the threshold displacement.
[3] Source: Aerial imagery copyright © 2020 Google.
[4] The TODA and ASDA have been extended to consider the new runway length which is 1773.53m.

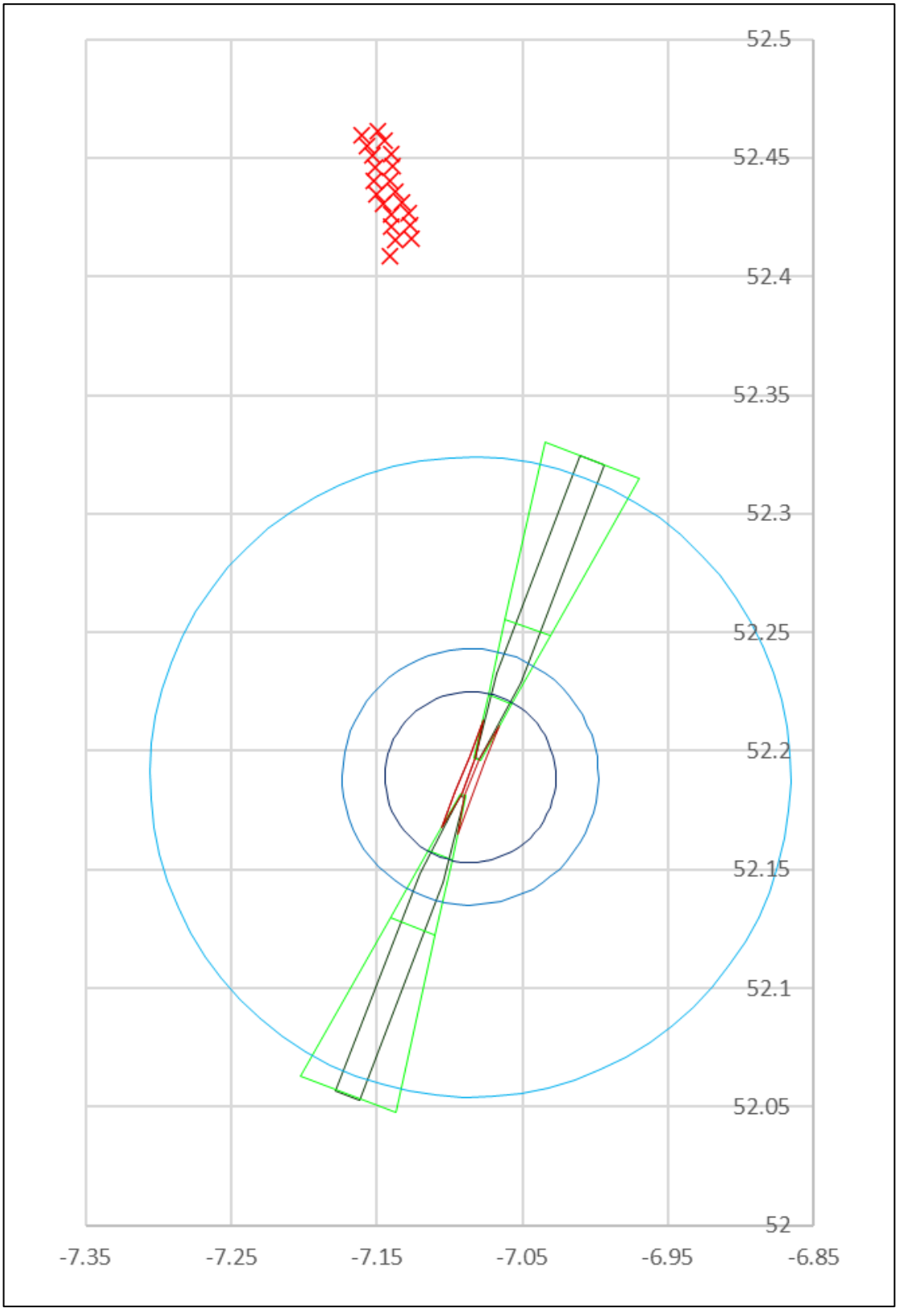

Figure 4 *Waterford Obstacle Limitation Surfaces – new runway 21 threshold.*

3.3.1 Obstacle Limitation Surfaces Results – New Runway 21 Threshold

Whilst the OLS does extend further north, the analysis has shown that the proposed wind development would still not infringe the OLS at Waterford Airport if the runway were to be extended. No impacts are therefore predicted.

3.4 Aviation Lighting

The ICAO has produced written guidance with respect to aviation lighting for tall structures[5]. The guidance states that all objects outside the vicinity of an aerodrome which extend to a height of 150m or more above ground level are considered obstacles and therefore require aviation lighting.

The guidance also states that where lighting is recommended for a wind farm specifically, it should be of installed:

a) To identify the perimeter of the wind farm;
b) With a maximum spacing between the lights along the perimeter is 900m or less, unless shown that a greater spacing can be used;
c) Where flashing lights are used, they should flash simultaneously;
d) Within the wind farm, any wind turbines of significantly higher elevation are identified wherever located.

Due to the height of the proposed turbines (185m agl) and their position relative to the aerodrome, it is expected that medium intensity aviation lighting mounted on all turbine nacelles will be required. There also may be a requirement to implement intermediate level lighting at half the nacelle height.

It is recommended that the lighting and marking requirements for the development are discussed with the IAA.

[5] ICAO Annex 14 – Aerodromes.

4 INSTRUMENT FLIGHT PROCEDURES (HIGH-LEVEL OVERVIEW)

4.1 Overview

A high-level assessment of existing and proposed IFPs is presented below. The analysis considers clearance distances and existing obstructions.

4.2 Description of Instrument Flight Procedures

Instrument flight procedures are published documents that consist of defined three dimensional routes for aircraft arriving and departing airports. In reality, aircraft do not necessarily fly these routes exactly due to limitations on the performance of aeronautical instruments, pilots and variations in wind and pressure conditions.

This means that an area around and beneath these three-dimensional routes must be kept clear of obstacles to ensure that there is no significant collision risk to aircraft flying these procedures as shown in Figure 5 below.

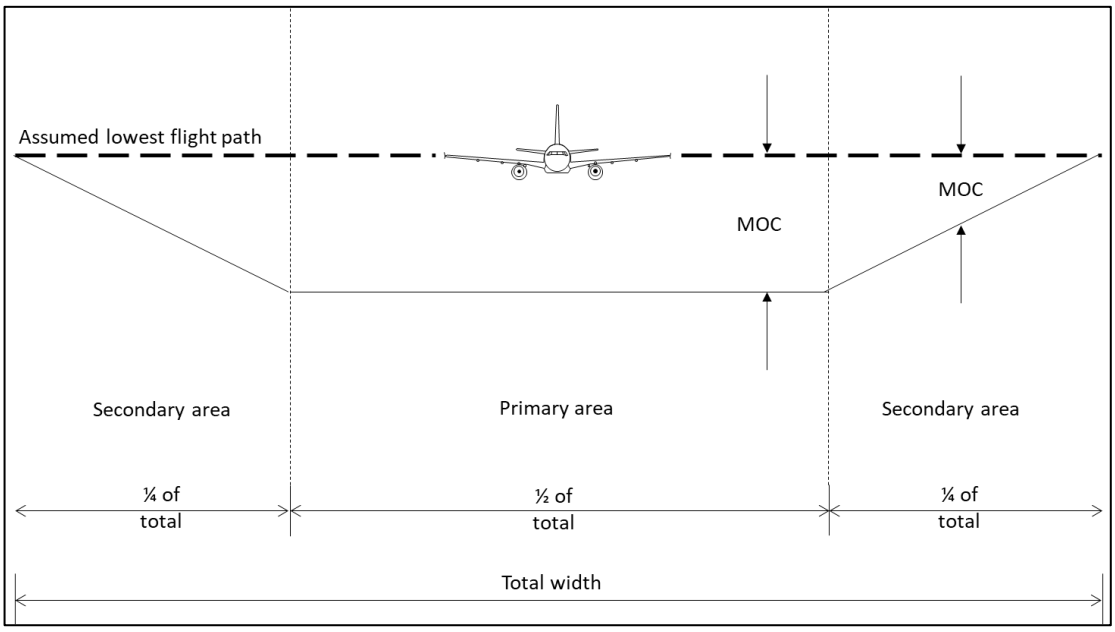

Figure 5 *Instrument Flight Procedure Minimum Obstacle Clearances*

4.3 Maximum Elevation Figure

The Maximum Elevation Figure (MEF) shows the maximum altitude of the highest terrain or structure in a particular quadrangle of a standard aeronautical chart. The MEF shown for the quadrangle in which the development is located is 1,600 feet. The proposed wind development has a maximum altitude of 1,447.8 feet (T6) which is 152.2 feet below this figure. Aircraft flying in accordance with the published MEF will not be affected by the wind farm.

4.4 Relevant Existing Instrument Flight Procedures at Waterford Airport

There are two charts within the AIP for Waterford Airport with IFP procedures that show routes that come close to the proposed development. These are shown in Table 4 below along with an initial commentary on potential impacts.

Chart	Description	Initial commentary on potential impacts
EIWF AD 2.24-3.1	Instrument Approach Chart ILS/NDB/DME RWY 21 – ICAO	The closest turbine in the proposed development is 6.25 nautical miles (NM) from the closest approach. As this is more than 5 NM, the horizontal clearance is sufficiently large to suggest there will be no impacts on these procedures.
EIWF AD 2.24-5	Instrument Approach Chart NDB/DME RWY 21 – ICAO	
EIWF AD 2.24-6.1	Instrument Approach Chart NDB/DME RWY 03 – ICAO	

Table 4 *Initial commentary – IFPs at Waterford Airport*

4.5 Surveillance Minimum Altitude Chart

Surveillance Minimum Altitude Charts (SMAC) are published to show the lowest altitude a pilot will be instructed to fly whilst receiving radar-based Air Traffic Control (ATC) service.

However, due to the lack of radar coverage in the area, Waterford Airport does not have a SMAC. No impacts upon SMACs are therefore expected.

4.6 New Runway Dimensions and IFPs

The threshold of the proposed new runway is approximately 420m closer to the proposed wind farm. The separation between the wind farm therefore remains greater than 5nm for all existing IFPs, as discussed in Table 4.

It is expected that the new runway will bring about new IFPs and, following consultation with Waterford Airport, it is known they are specifically interested regarding the impact upon the proposed IFP centred on the DME on an arc out to 12nm at 2,000ft.

Figure 6[6] on the following page shows the existing IFP for an 8.3nm arc centred on the DME. The 8.3nm arc section of the procedure is highlighted in red for reference. It is anticipated that a 12nm arc procedure would be similar but with a larger radius.

[6] Source: IAA AIP.

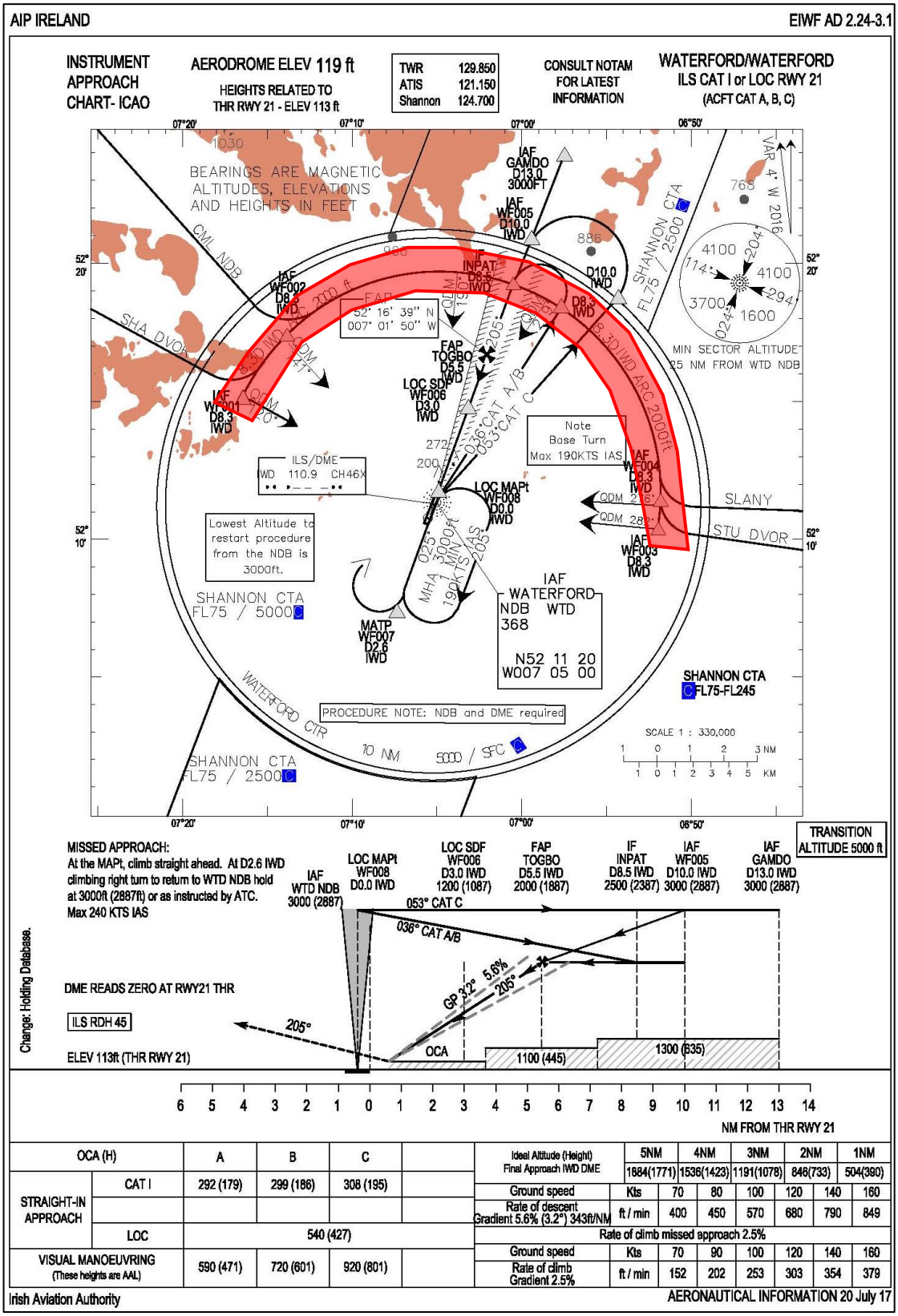

Figure 6 *Instrument Approach Chart ILS/NDB/DME RWY 21 – ICAO*

Figure 17 below shows a 12nm arc centred on the new runway threshold. The proposed wind farm is shown as well as an exisiting wind farm. The maximum elevation of the nearest propsoed wind turbine to the arc is T1, which is 1,295.3ft (highlighted blue). The turbine with the highest altitude within the proposed wind farm is T6, which is 1,447.8ft (highlighted red). The maximum elevation of the existing wind farm (shown as blue crosses) is 1,050ft. No differentiation between the turbine altitudes for the existing wind farm is given due to their proximity to the arc.

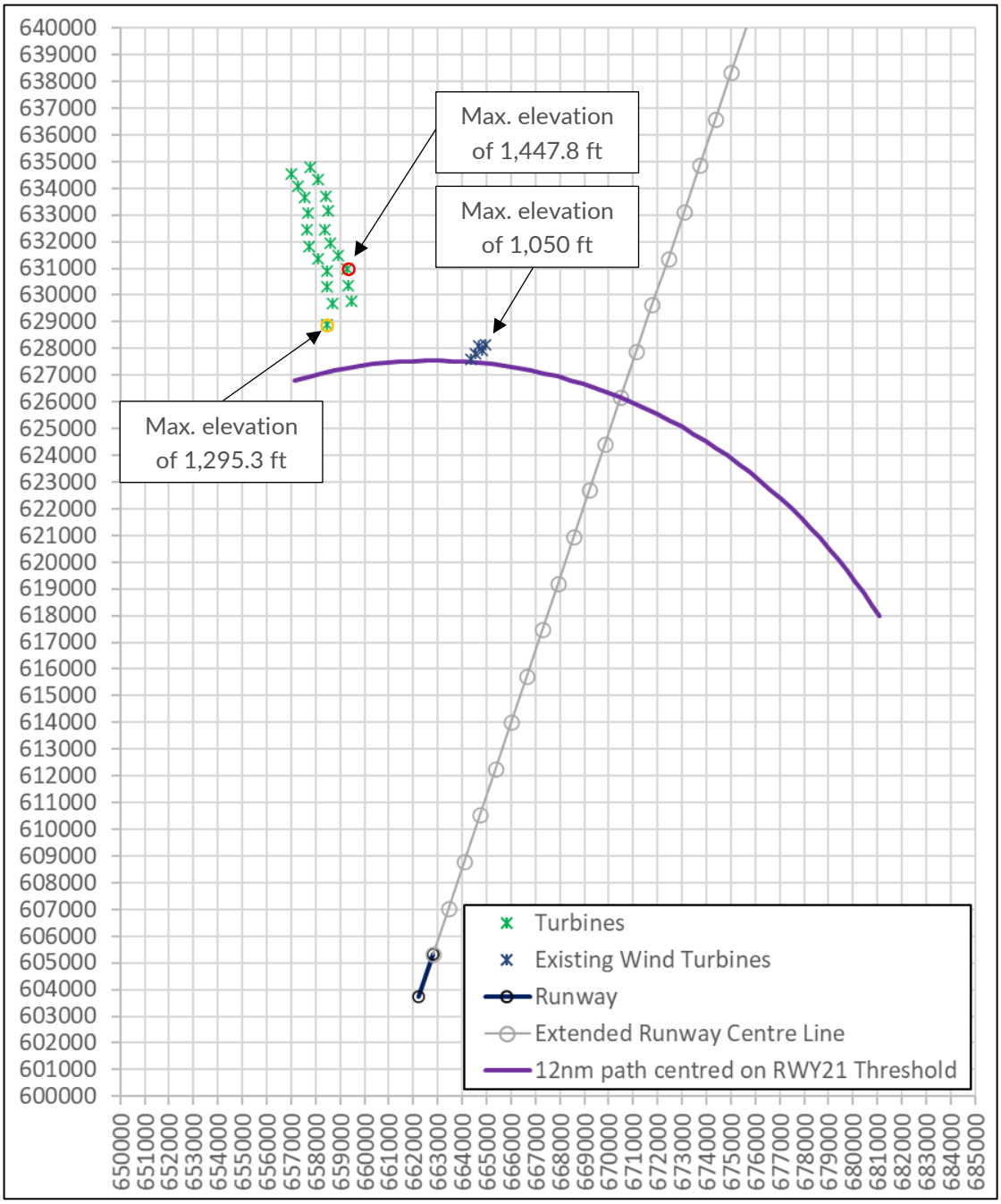

Figure 7 *12nm arc about the DME relative to the existing and proposed wind farms*

The minimum vertical clearance between an IFP and any obstructions is 1,000ft at the associated lateral clearance to the proposed and existing wind farms. Considering the proximity of the existing wind farm, an IFP altitude of 2,000ft is not viable[7] as the vertical clearance (950ft) is below the minimum required vertical clearance.

To accommodate the existing wind farm, the minimum altitude of the IFP would have to be 2,050ft. To accommodate the proposed wind farm, the minimum altitude of the IFP would have to be 2,448ft. Considering the existing airspace, a procedure change to ensure the minimum vertical clearance between the existing and proposed wind farm can reasonably be accommodated.

Following a review of the relevant aviation chart, if a procedure did have a 12nm radius, the CTR (Control Zone) would have to increase in size and therefore airspace would inherently have to be redesigned

Furthermore, consultation with Waterford Airport revealed that a new RNAV procedure may be created as part of the runway extension. Considering an existing RNAV procedure at Cork Airport (for comparison), it can be seen that this procedure could be accommodated considering the proposed wind farm. Simplistically, the Cork Airport RNAV procedure could be described as a procedure commencing at 3,000ft with a descent starting at 8nm from the runway. If this procedure were to be similarly replicated at Waterford Airport, the proposed wind farm would be well clear vertically and horizontally of the aircraft.

Finally, there are no existing holding patterns in the vicinity of the proposed wind farm which could be affected. The plans for the new holding patterns are not known. Currently the holding patterns are at least 12nm from the proposed wind farm.

4.7 Instrument Flight Procedure Conclusions

All high-level assessments have shown that the clearance distances between the assessed existing procedures and the proposed turbines exceed all relevant clearance minima.

With respect to new IFPs as a result of the runway extension, any new IFPs could be designed around the wind farm to ensure minimum clearance distances if it were required however consultation with Waterford Airport would need to be undertaken. Considering the existing wind farm alone, a 2,000ft DME 12nm arc would not have the required vertical clearance.

[7] 2,000fr – 1,050ft (maximum altitude of the existing wind farm) = 950ft.

5 OVERALL CONCLUSIONS

5.1 Technical Findings

5.1.1 Obstacle Limitation Surfaces

The proposed wind development does not infringe any of Waterford Airport's Obstacle Limitation Surfaces. This conclusion remains the same considering the proposed larger runway. No impacts are therefore predicted.

5.1.2 Instrument Flight Procedures

All high-level assessments have shown that the clearance distances between the assessed existing IFPs and the proposed wind farm exceed all relevant clearance minima.

With respect to new IFPs as a result of the runway extension, a 2,000ft DME 12nm arc has been assessed. Considering an existing wind farm, a 1,000ft clearance would not be possible. Therefore the minimum altitude would need to be increased, in doing so, steps could be taken to accommodate the proposed wind farm to ensure minimum clearance distances.

5.2 Overall Conclusions and Recommendations

The proposed wind farm is unlikely to have a significant impact upon the existing aviation activity associated with Waterford Airport. The wind farm is outside of the OLS, including consideration of the new runway. No current IFPs are expected to be affected.

Calculations show that the proposed 2,000ft DME 12nm IFP is not possible in its current form as vertical clearance would not be maintained considering an existing wind farm in close proximity to the 12nm arc. This IFP would therefore have to be re-considered and in doing so, steps could be taken to accommodate the proposed wind farm. Consultation with Waterford Airport is recommended on this point.

Due to the height of the proposed turbines (185m agl) and their position relative to the aerodrome, it is expected that medium intensity aviation lighting mounted on all turbine nacelles will be required. There also may be a requirement to implement intermediate level lighting at half the nacelle height.

It is recommended that the lighting and marking requirements for the development are discussed with the IAA.

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