

# Derryadd Wind Farm

## Flood Risk Assessment

January 2019

Revision A

TOBIN CONSULTING ENGINEERS



# REPORT

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**Derryadd Wind Farm**

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## Table of Contents

<b>1 INTRODUCTION .....</b>	<b>1</b>
<b>2 HISTORICAL FLOODING &amp; FLOOD MAPS .....</b>	<b>2</b>
2.1 OPW FLOOD MAPS .....	2
2.2 OPW PRELIMINARY FLOOD RISK ASSESSMENT (PFRA) MAPS .....	3
2.3 SHANNON CFRAM.....	5
<b>3 PLANNING AND FLOOD RISK MANAGEMENT GUIDELINES .....</b>	<b>6</b>
3.1 THE PLANNING SYSTEM & FLOOD RISK MANAGEMENT GUIDELINES.....	6
3.1.1 <i>Justification Test Criteria</i> .....	7
3.2 THE FLOOD RISK MANAGEMENT CLIMATE CHANGE ADAPTATION PLAN .....	8
3.3 THE LONGFORD COUNTY DEVELOPMENT PLAN (2015-2021) .....	9
<b>4 FLOOD RISK ASSESSMENT .....</b>	<b>11</b>
4.1 FLUVIAL FLOOD RISK .....	11
4.2 GROUNDWATER FLOOD RISK.....	11
4.3 PLUVIAL FLOOD RISK.....	12
4.4 THE JUSTIFICATION TEST .....	12
<b>5 CONCLUSION .....</b>	<b>14</b>

# 1 INTRODUCTION

TOBIN Consulting Engineers were appointed in January 2016 to provide engineering and environmental consultancy services for the design and planning of the proposed Derryadd Wind Farm development in Co. Longford.

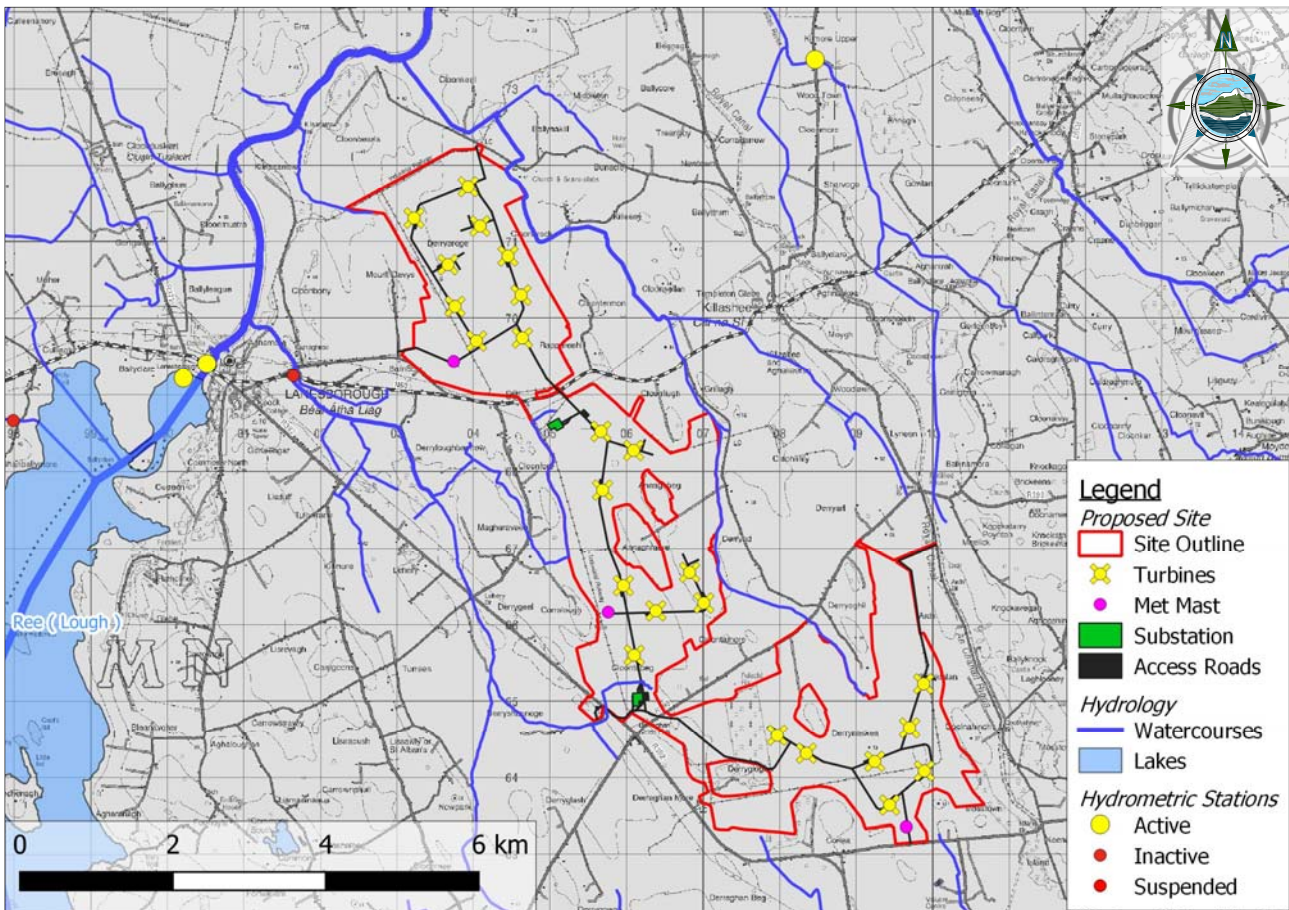
The location of the site is shown in Figure 1.

The development includes of the following works:

- Construction of 24 no. Wind Turbines
- Construction of 3 no. Met Masts
- Construction of 1 no. electric substation
- Construction of local access roads and turbine hardstand areas
- Site drainage and other ancillary services

The Flood Risk Assessment (FRA) has been prepared in accordance with the guidelines produced by the Department of Environment, Heritage and Local Government (DoEHLG) *The Planning System and Flood Risk Management Guidelines for Planning Authorities, 2009.*

Figure 1 Site Overview Map



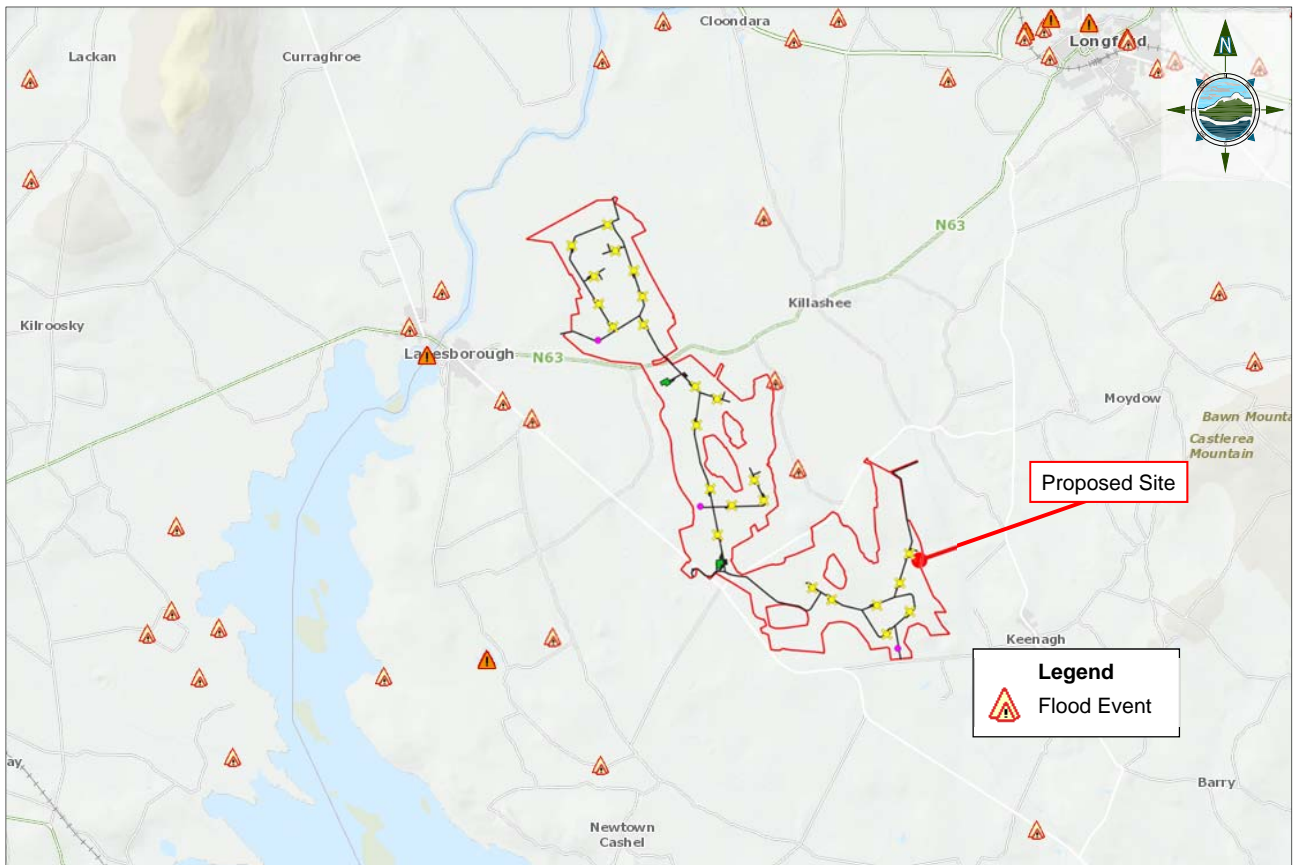
## 2 HISTORICAL FLOODING & FLOOD MAPS

### 2.1 OPW FLOOD MAPS

The OPW’s online National Flood Hazard Mapping database<sup>1</sup> provides information on reported floods, in the form of reports, photos and newspaper articles.

The database does not provide any record of flood events occurring at the proposed development site. However, there are reports of recurring river flood events in the surrounding area, see Figure 2.

Figure 2 Extract from National Flood Hazard Mapping database



<sup>1</sup> [www.floodmaps.ie](http://www.floodmaps.ie)

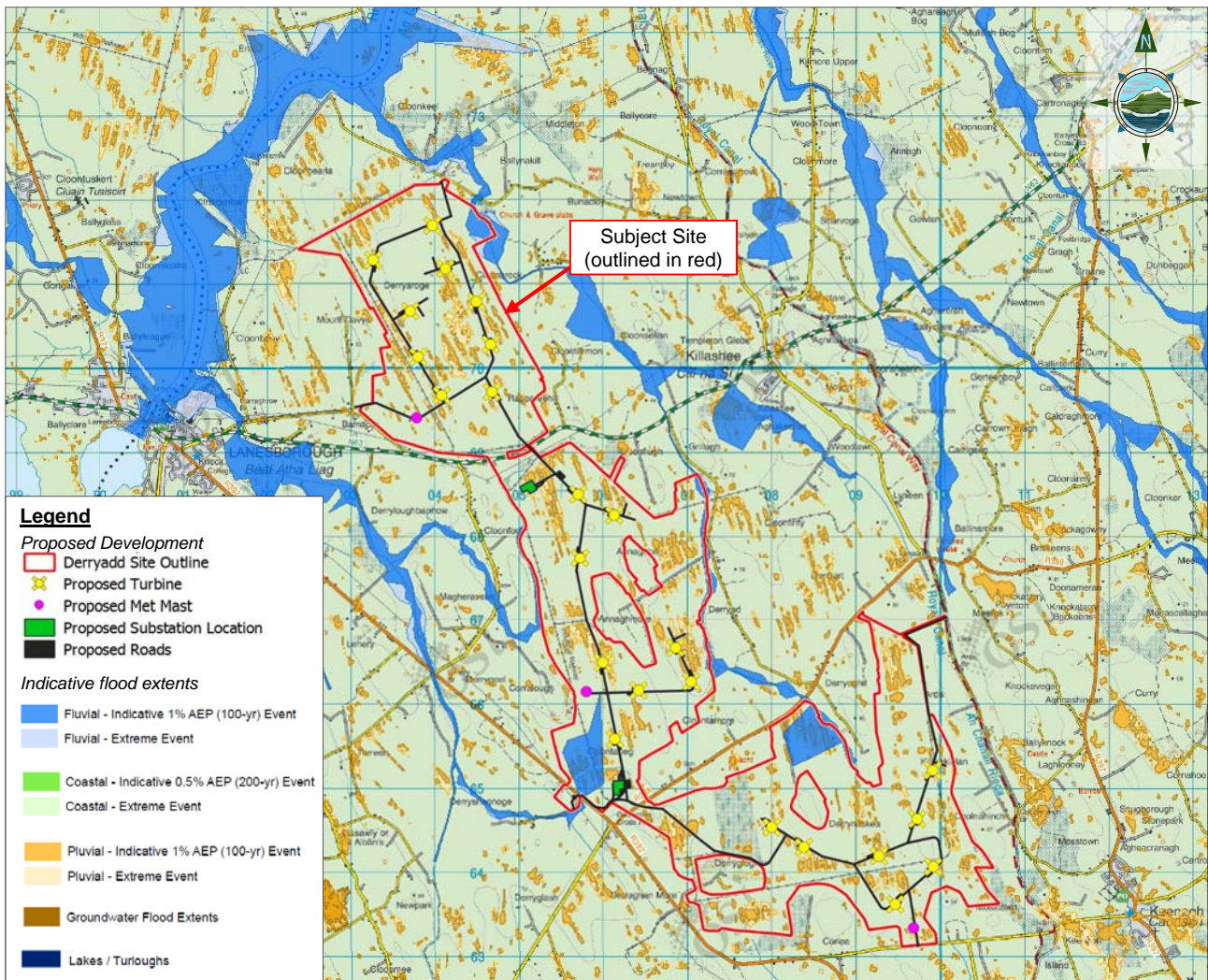


## 2.2 OPW PRELIMINARY FLOOD RISK ASSESSMENT (PFRA) MAPS

In 2009 the OPW produced a series of maps to assist in the development of a Preliminary Flood Risk Assessment (PFRA) throughout the country. These maps were produced from a number of sources. It should be noted that “the flood extents shown on these maps are based on broad-scale simple analysis and may not be accurate for a specific location”<sup>2</sup>.

The indicative flood mapping of the area shows portion of the subject site as being liable to fluvial and pluvial flooding, see Figure 3.

Figure 3 Indicative Flood Mapping from OPW PFRA Study



### Fluvial Flood Risk

The indicative flood mapping of the area shows a portion of the subject site as being liable to fluvial (river) flooding, see Figure 3.

None of the sensitive elements of the development (turbines, substation, roads) are indicated to be at risk.

Detailed hydraulic modelling of the River Shannon (to the north of the site) was carried out as part of the Shannon CFRAM Study; refer to Section 2.3 of this report.

<sup>2</sup> The National Preliminary Flood Risk Assessment (PFRA) Overview Report, OPW (March 2012)

### **Pluvial Flood Risk**

Pluvial modelling was carried out by HR Wallingford in November 2010 as part of the PFRA study. The 100- and 1000-year flood extents were generated by analysing 1, 3, 6, and 24-hour rainfall events. The design storm rainfall was applied to the National Digital Terrain Model (DTM) with an allowance for infiltration based on the soil type in the area.

The DTM used for the PFRA study's flood plain mapping was generated from RADAR based technology in 2007 and is stated to have a 5m horizontal resolution (re-sampled to 10m resolution) and 0.01m vertical resolution, to a quoted vertical accuracy of 0.5m RMSE<sup>3</sup>. The accompanying report to the PFRA notes that the process "*due to the scale of analysis, has not taken into account local drainage structures such as culverts through embankments or other local drainage that would not be resolved in the DTM at a national scale*".

The PFRA pluvial flood maps were also adapted by the OPW to show only the extents where the flood depths were greater than 200mm (on the basis that depths lower than this would not cause significant damage given door-step levels above ground level)<sup>4</sup>.

The analysis carried out by HR Wallingford as part of their PFRA study indicates that pluvial flooding (ponding of surface water) may occur within the proposed site following an extreme rainfall event (see Figure 3).

A number of the proposed roads and turbines are located in area which are indicated to be at risk from pluvial flooding.

However, it should be noted that there is an extensive arterial drainage network in the site at present which would not have been considered by the PFRA modelling. The extents of flooding indicated are therefore likely to be reduced.

### **Groundwater Flood Risk**

As part of the PFRA study indicative groundwater flood mapping was produced by Mott Mac Donald Ltd. A model-based approach to generate groundwater flood extents was not possible due to the lack of available data. Therefore, the following methods were used:

- 1) *"The use of existing mapping of past groundwater flood events (e.g., from 1994/95, and late 2009), developed from ground-based observation, aerial photography or satellite imagery and the maximum extents observed"*;
- 2) *"The delineation of flood extents around turloughs based on an assumed height of flooding of 4m above the base elevation of the turlough (the median of observed ranges) using the OPW's national DTM, with manual adjustment to ensure pragmatic extents"*;
- 3) *"The use of records of past groundwater flood events to validate or adjust the flood extents derived using the other approaches"*.

*"It should be noted that due to the absence of a model-based approach, only one set of flood extents were generated, with no specific event probability (although where observed flood data was used, these are likely to represent quite extreme events)."*<sup>5</sup>

The PFRA mapping did not indicate any sources of groundwater flooding in the vicinity of the proposed site.

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<sup>3</sup> National Pluvial Screening Project for Ireland (HR Wallingford, November 2012)

<sup>4</sup> The National Preliminary Flood Risk Assessment (PFRA) Overview Report (OPW, March 2012)

<sup>5</sup> The National Preliminary Flood Risk Assessment (PFRA) Overview Report (OPW, March 2012)



### 2.3 SHANNON CFRAM

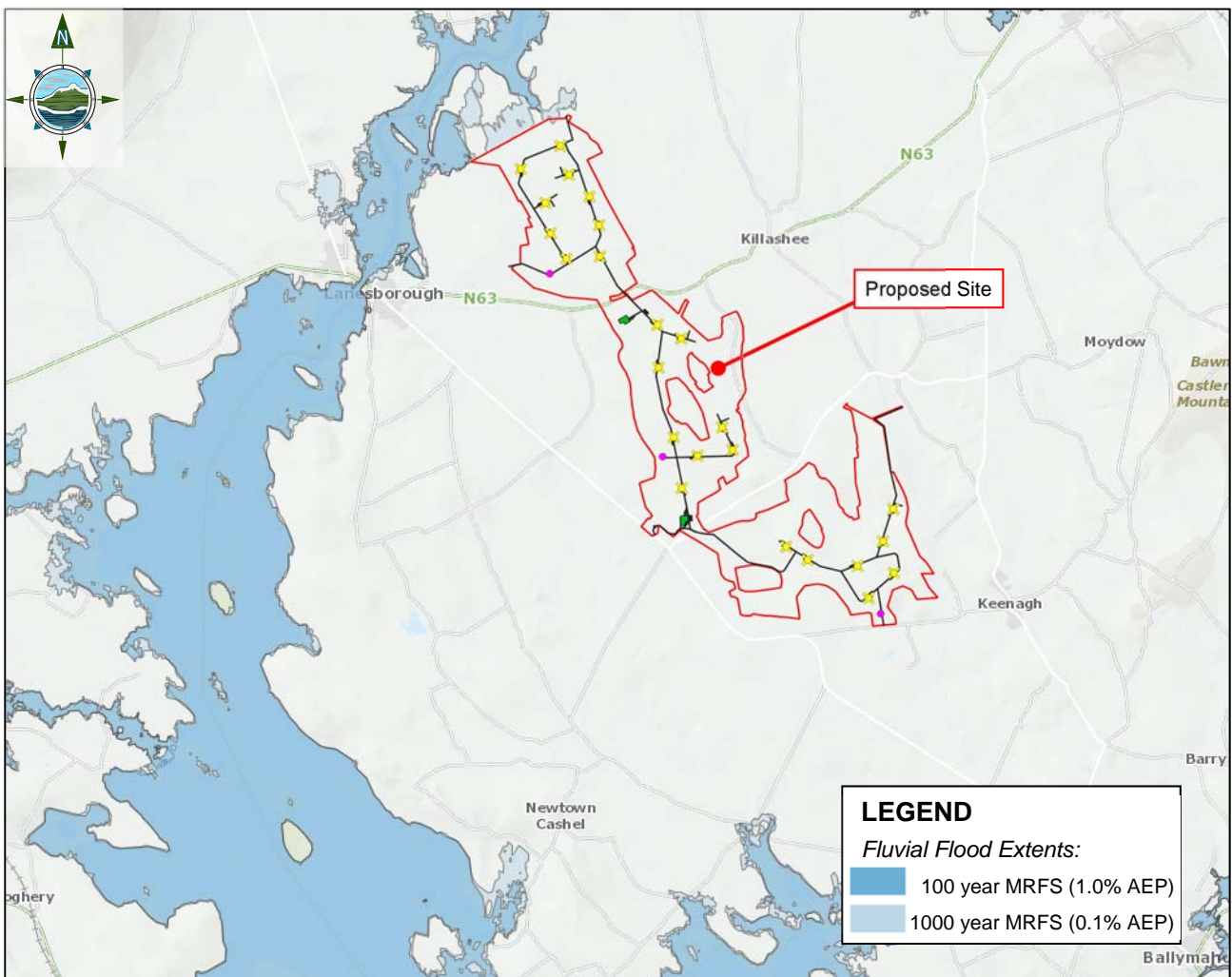
As part of the *Shannon Catchment Flood Risk Assessment and Management (CFRAM)* programme hydraulic modelling of the River Shannon and her major tributaries was carried out by JACOBS Consulting in 2015. The final fluvial flood extents were published in June 2016.

The predicted flood extents of the River Shannon during the 100 and 1000 year Mid Range Future Scenarios (MRFS) are shown in Figure 4.

It is our understanding that this mapping was produced using a digital terrain model based on a combination of LiDAR and other ground elevation data. The OSI quote the vertical accuracy of LiDAR data as being +/-25cm.

Based on the results of the CFRAM study (Figure 4), parts of the proposed site are liable to flooding during the 1000 year MRFS. It is estimated that none of the sensitive elements of the development (turbines, substations, roads and masts) will be impacted by fluvial flooding from the River Shannon.

**Figure 4 Predicted MRFS Fluvial Flood Extents [Shannon CFRAM study]**



### 3 PLANNING AND FLOOD RISK MANAGEMENT GUIDELINES

This section of the report considers the following plans and guidance documents:

- The Planning System and Flood Risk Management Guidelines (OPW & DOEHLG 2009)
- The Flood Risk Management Climate Change Adaptation Plan (OPW 2015)
- The Longford County Development Plan 2015-2021

#### 3.1 THE PLANNING SYSTEM & FLOOD RISK MANAGEMENT GUIDELINES

The ‘*The Planning System and Flood Risk Management*’ (PSFRM) guidance document, published in 2009 by The Department of Environment, Heritage and Local Government (DoEHLG) and the Office of Public Works (OPW), discuss flood risk in terms of three flood zones. It also identifies vulnerability classes for development in order to define what type of development is suitable within what flood zone and when the Justification Test should be applied.

The flood zones, vulnerability classes and requirement for the Justification Test is summarised in Table 1.

**Table 1 Matrix of vulnerability versus flood zone to illustrate appropriate development and that are required to meet the Justification Test (Extract from the PSFRM Guidelines)**

Flood Zone	Probability of Flooding (Return Period)	Recommendation based on Vulnerability of Development		
		Highly Vulnerable or Essential Infrastructure	Less Vulnerable	Water Compatible
A	High Probability (more frequent than 1 in 100-yr)	Justification Test	Justification Test	Appropriate
B	Moderate Probability (1 in 100-yr to 1 in 1000-yr)	Justification Test	Appropriate	Appropriate
C	Low Probability (less frequent than 1 in 1000-yr)	Appropriate	Appropriate	Appropriate

Note: The PSFRM Guidelines provide probabilities for fluvial, pluvial and tidal flooding. For clarity tidal flooding probabilities have been omitted from this table.

The PSFRM Guidelines classifies electricity generating stations as “essential infrastructure”. The proposed windfarm has therefore been assessed against the 1,000-year flood event.

### 3.1.1 Justification Test Criteria

Box 5.1 of “*The Planning System and Flood Risk Management Guidelines*” (PSFRM Guidelines) outlines the criteria required to complete the “Justification Test”; see Figure 5.

The proposed development has been assessed against the criteria of the Justification Test in Section 4.4 of this report.

**Figure 5 Justification Test Criteria (Extract from the PSFRM Guidelines)**

**Box 5.1 Justification Test for development management  
(to be submitted by the applicant)**

When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied:

1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.
2. The proposal has been subject to an appropriate flood risk assessment that demonstrates:
  - (i) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;
  - (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;
  - (iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and
  - (iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

The acceptability or otherwise of levels of residual risk should be made with consideration of the type and foreseen use of the development and the local development context.

### 3.2 THE FLOOD RISK MANAGEMENT CLIMATE CHANGE ADAPTATION PLAN

The Flood Risk Management Climate Change Adaptation Plan (published May 2015) has been prepared under the remit of the National Climate Change Adaptation Framework. It sets out the policy on climate change adaptation of the Office of Public Works (OPW), the lead agency for flood risk management in Ireland, based on a current understanding of the potential consequences of climate change for flooding and flood risk in Ireland, and the adaptation actions to be implemented by the OPW and other responsible Departments and agencies in the flood risk management sector.

The document recommends two future flood risk scenarios for considering future implications of factors, including climate change, in relation to future flooding. The Mid-Range Future Scenario (MRFS) recommends a “likely” future scenario while the High-End Future Scenario (HEFS) represents a more “extreme” future scenario. Table 2 sets out the allowances for both of these scenarios.

**Table 2 Allowances in Flood Parameters for the Mid-Range and High-End Future Scenarios**

<b>Parameter</b>	<b>MRFS</b>	<b>HEFS</b>
Extreme Rainfall Depths	+ 20%	+ 30%
Peak Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 500 mm	+ 1000 mm
Land Movement	- 0.5 mm / year <sup>1</sup>	- 0.5 mm / year <sup>1</sup>
Urbanisation	<i>No General Allowance – Review on Case-by-Case Basis</i>	<i>No General Allowance – Review on Case-by-Case Basis</i>
Forestation	- 1/6 Tp <sup>2</sup>	- 1/3 Tp <sup>2</sup> + 10% SPR <sup>3</sup>

Note 1: Applicable to the southern part of the country only (Dublin – Galway and south of this)

Note 2: Reduction in the time to peak (Tp) to allow for potential accelerated runoff that may arise as a result of drainage of afforested land

Note 3: Add 10% to the Standard Percentage Runoff (SPR) rate: This allows for temporary increased runoff rates that may arise following felling of forestry.

For the purpose of this flood risk assessment, we have assessed the proposed development against the Mid Range Future Scenario as it represents a likely future scenario.



### 3.3 THE LONGFORD COUNTY DEVELOPMENT PLAN (2015-2021)

Section 5.3 of the Longford County Development Plan (CDP) discusses flooding and flood risk management.

Some of the key objectives of the plan, relating to flood risk are quoted below:

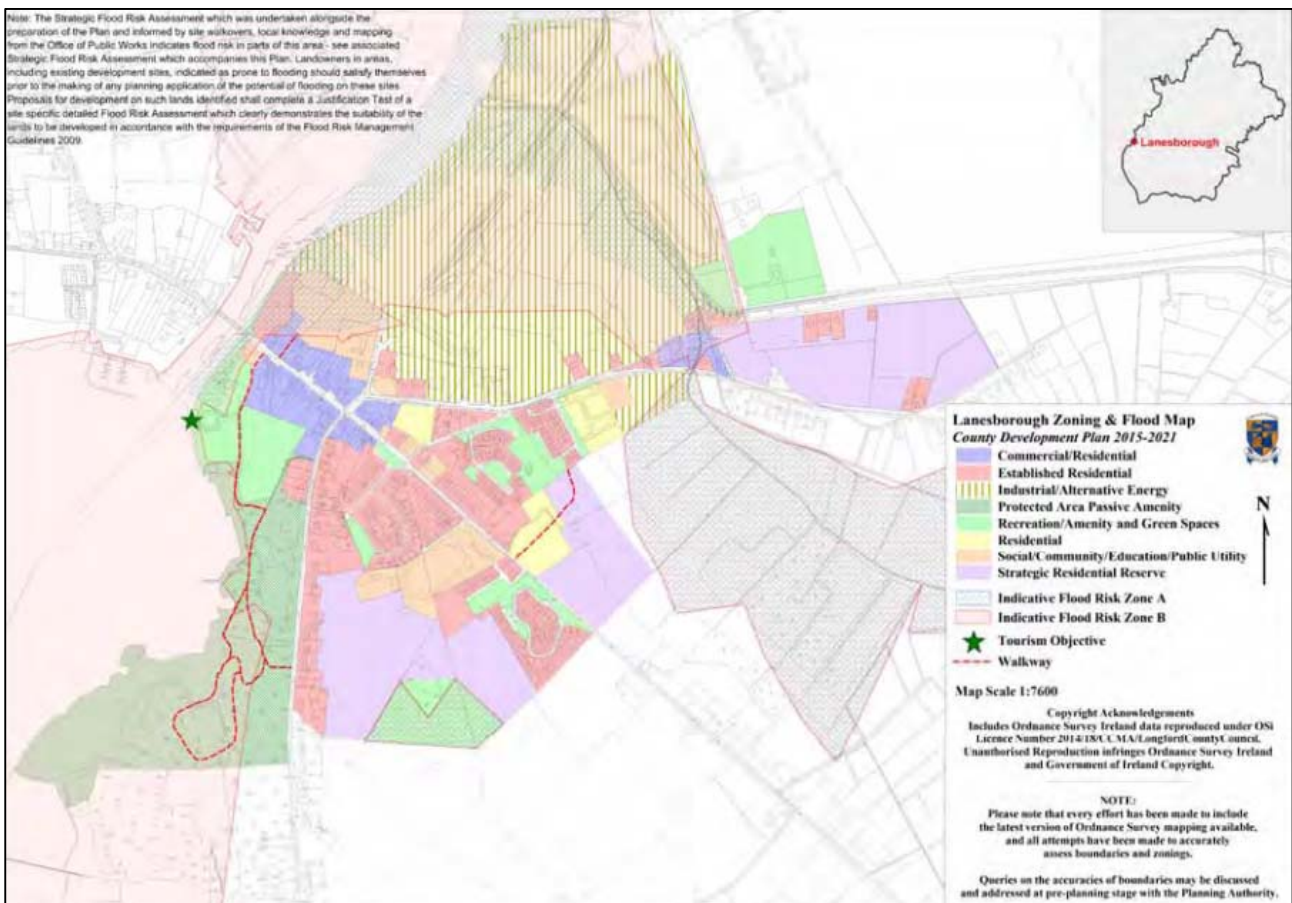
- *“In areas susceptible to flooding, development may be restricted and where necessary developers will be required to submit a Flood Risk/Impact Assessment and proposals for a Sustainable Urban Drainage System (SUDS). This shall also apply in areas where it is considered that the proposed development will impact on flooding elsewhere.;*
- *“It is the policy of the Council to protect Flood Zone A and Flood Zone B from inappropriate development and direct developments/ land uses into the appropriate Flood Zone in accordance with the Flood Risk Management Guidelines 2009 (or any superseding document). Where a development/land use is proposed that is inappropriate within the Flood Zone, then the development proposal will need to be accompanied by a Development Management Justification Test and site-specific FRA in accordance with the criteria set out under the Flood Risk Management Guidelines;*
- *The Council shall implement the recommendations and provisions of the DEHLG/ OPW publication Flood Risk Management Guidelines 2009 (or any updated/superseding document) in relation to flood risk management within the County*
- *“The Council, in tandem with the OPW, will support the preparation, establishment and implementation of any future Flood Risk Assessment and Management Studies prepared for catchments within the County area.*
- *Where the probability of flooding from rivers is low (less than 0.1% flood zone C) the developer should satisfy him or herself that the probability of flooding is appropriate to the development being proposed. Among other things, mapping including the OPW’s Pluvial and Groundwater Preliminary Flood Risk Assessment mapping should be considered for this purpose.*
- *Planning applications on lands identified within groundwater and pluvial PFRA areas shall be accompanied by a site-specific FRA that corresponds with that outlined under Chapter 5 ‘Flooding and Development Management’ of the Flood Risk Management Guidelines. Such assessments shall be prepared by suitably qualified experts with hydrological experience and shall quantify the risks and the effects of any necessary mitigation, together with the measures needed or proposed to manage residual risks.*
- *In the case of lands transected by the outer boundary of Flood Zone A or B, where it can be demonstrated to the satisfaction of the Planning Authority (by more detailed local topographic survey information) that the outer boundary does not reflect local topographical and /or flood path conditions, the Planning Authority may consider the extension of uses allowed in an adjacent land use zone into the Flood Zone area. The proposal will also be subject to the submission of a site-specific FRA and Justification Test as appropriate and the developer satisfying the Planning*

Authority and him/herself that the probability of flooding is appropriate to the development being proposed and will not increase flood risk elsewhere.

- Where Flood Zones have been zoned according to the information contained in a site-specific FRA provided by the land owner this should be noted on the relevant zoning map.

A Strategic Flood Risk Assessment was carried out for County Longford as part of the 2015-2021 CDP. This report discussed the finding of the OPW's Preliminary Flood Risk Assessment (PFRA) study at some locations. The proposed site (subject of this report) was not discussed specifically. The zoning and flood map of Lanesborough is shown in Figure 6 below, which indicates the flood risk is low at the proposed site. The subject lands are zoned for development.

Figure 6 Zoning and Flood Map of Lanesborough (extract from Longford County Development Plan 2015-2021)



## 4 FLOOD RISK ASSESSMENT

Referring to Section 3.1, the proposed wind farm development is classified as “essential infrastructure”. The PSFRM guidance document recommends that such developments be constructed in ‘Flood Zone C’, i.e. that there is less than a 0.1% probability of the site flooding. Accordingly, the proposed development has been assessed against a 1000-year flood event (i.e. 0.1% Annual Exceedance Probability).

### 4.1 FLUVIAL FLOOD RISK

Based on the results of the PFRA and Shannon CFRAM studies, it is estimated that parts of the site are liable to fluvial flooding during the 1000 year MRFS event.

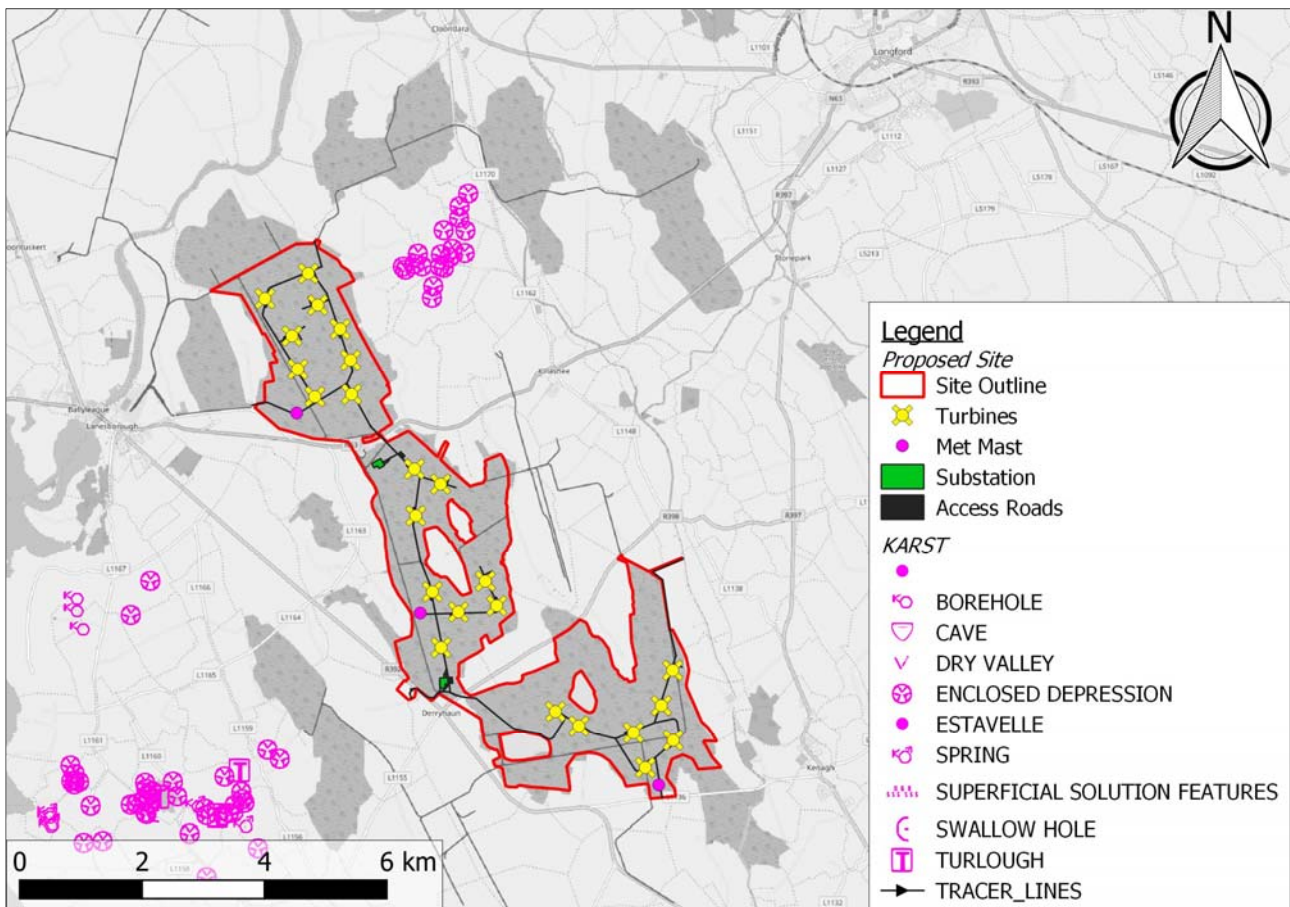
Referring to Figure 3 and Figure 4, it is predicted that the sensitive elements of the development (wind turbines, substations, masts and access roads) are located in Flood Zone C; i.e. they are not liable to flooding during a 1000 year MRFS event.

Based on the available information, it is estimated that the risk of fluvial flooding to the development is minimal.

### 4.2 GROUNDWATER FLOOD RISK

Based on the results of the PFRA study, and mapping by the GSI<sup>6</sup> there is no evidence to suggest groundwater flooding at the proposed site.

Figure 7 Karst features in vicinity of proposed site [GSI database]



<sup>6</sup> Geological Survey Ireland Spatial Resources online mapping

### 4.3 PLUVIAL FLOOD RISK

Hydraulic modelling, by HR Wallingford as part of the PFRA study, indicated that parts of the proposed site are liable to pluvial flooding (ponding of surface water). A number of the proposed turbines, substations and access roads are located on existing ground indicated as being liable to pluvial flooding.

It was noted that there is an extensive arterial drainage network at the site at present. Due to the assumptions made by the national PFRA study, this local land drainage would not have been accounted for. While this may reduce the extents of flooding at the site, it is our understanding that pluvial flooding does still occur at some locations.

Surface water discharges from the site are currently attenuated to greenfield runoff rates. Discharge from the site is pumped and controlled within the existing IPC licence for the site and will continue to be managed in accordance with the IPC licence and peatland restoration plans. There is no proposal to increase pumping as a result of the proposed development.

#### **Mitigation Measures**

A number of mitigation measures are proposed by the design team to manage flood risk to these elements of the development.

The proposed electricity generating infrastructure (turbines, masts and substations) and access road will be raised above the estimated pluvial flood level. This will minimise the flood risk to the development.

Compensatory flood plain storage shall also be provided to accommodate the raising of ground levels in flood prone area.

Surface water arising onsite will be managed by the existing surface water management system. In accordance with the SUDS design principals, discharge from the site will be limited to greenfield rates to ensure that peak flood flows and flood risk will not be impacted outside the site.

Surface water will be held on site in shallow wet areas, low lying areas, settlement ponds, field/main drains, and upstream of pumping stations. Given the large area of the site it has a large capacity to store water following rainfall events.

The landscaping and topography of the developed site shall provide safe exceedance flow paths in the event of extreme flood events or in the case of a blockage of the drainage system, so as to minimise risks to people and property.

Although mitigation measures are proposed to control flood risk associated with the development, the proposal has been specifically assessed against the criteria of the PSFRM's '*Justification Test*' in Section 4.4 of this report.

### 4.4 THE JUSTIFICATION TEST

Based on the results of this flood risk assessment, it is predicted that a portion of the subject site may be liable to fluvial flooding during the 1000-year mid-range future scenario.

Referring to the OPW's PSFRM guidelines, the proposed development (classified as "highly vulnerable" in terms of its sensitivity to flooding) is appropriate for Flood Zone C. Therefore, the justification test needs to be applied.

Referring to Point 1 and Points 2 (i) to (iv) of the Justification test discussed in Section 3.1.1:

1. The subject lands have been zoned for development.



2. The development has been the subject of a flood risk assessment (this report) and this assessment has shown that:
- (i) Existing ground levels at the site will be raised in certain areas to facilitate the construction of turbines, masts, substation and access roads above the flood plain. Compensatory floodplain storage will be provided to ensure the net volume of surface water leaving the site will not be increased during a flood event.  
Surface water arising within the site will be managed by the existing surface water management system which will limit discharge to greenfield runoff rates.  
With these mitigation measures in place, it is predicted the proposed development will not impact flood risk elsewhere.
  - (ii) The sensitive elements of the development (turbines, masts, substation and access roads) will be constructed above the estimated pluvial flood level. In relation to the construction, operation and decommissioning of the proposed windfarm, it is estimated that the proposed mitigation measures will minimise the flood risk to people, property, the economy and the environment;
  - (iii) The proposed access roads, and electricity generating infrastructure will be constructed above the estimated pluvial flood level. It is estimated that access to the site for emergency services or essential maintenance will be possible during an extreme flood event. It is predicted that residual flood risk associated with the development can be managed.
  - (iv) The development is compatible with the wider planning objectives of the area.

The development as it is currently proposed meets the criteria of the justification test.

## 5 CONCLUSION

TOBIN Consulting Engineers were appointed in January 2016 to provide engineering and environmental consultancy services for the proposed Derryadd Wind Farm development in Co. Longford. This included a site-specific Flood Risk Assessment (FRA), detailed in this report.

The Flood Risk Assessment undertook a review of:

- OPW Flood Hazard mapping
- OPW Preliminary Flood Risk Assessment (PFRA) Study
- The Shannon CFRAM Study
- The Planning System & Flood Risk Management (PSFRM) Guidelines
- Flood Risk Management Climate Change Adaptation Plan
- Longford County Development Plan 2015-2021

With reference to the PSFRM guidelines, the proposed wind farm (an electricity generating development) is classified as essential infrastructure. Such developments are considered appropriate within Flood Zone C (areas not liable to flooding during a 1-in-1000 year Mid Range Future Scenario).

The outcome of the Flood Risk Assessment is summarised as follows:

### **Fluvial Flooding**

There are a number of watercourses located in/in the vicinity of the subject site. Based on the results of the PFRA and Shannon CFRAM studies it is predicted that portions of the site are liable to flooding during a 1000 year MRFS.

It is estimated that the sensitive elements of the development, i.e. the turbines, substations, masts and access roads, are located in Flood Zone C.

It is therefore estimated that the risk of fluvial flooding to the development is minimal.

### **Groundwater Flooding**

Based on a review of the PFRA study and GSI mapping of karst features in the area, there is no evidence to suggest groundwater flooding at the site.

### **Pluvial Flooding**

Hydraulic modelling carried out as part of the PFRA study indicates that a number of the proposed turbines, substations and access roads are located on existing ground, indicated by the PFRA study as being liable to pluvial flooding.

There is an existing arterial drainage network throughout the site at present, which would not have been considered by the national pluvial flood model. The extents of flooding indicated on the PFRA mapping is therefore likely to be reduced.

At present surface water discharges from the site are attenuated to greenfield runoff rates. Discharge from the site is mainly pumped and controlled within the existing IPC licence for the site and will continue to be managed in accordance with the IPC licence and peatland restoration plans. There is no proposal to increase pumping as a result of the proposed development.

A number of mitigation measures are proposed by the design team to address the risk of pluvial flooding associated with the development. This includes the raising of existing ground levels in some locations to facilitate the construction of electricity generating infrastructure (turbines, substations and masts) and access roads above the estimated flood level.

Surface water runoff from the site will be limited to greenfield runoff rates by the existing surface water management system.

It is predicted that the proposed measures minimise the flood risk to people, property, the economy and the environment.

It is estimated that the risk of flooding the proposed development will be minimal, and it is predicted that the development will not increase the risk of flooding elsewhere.

The proposed development satisfies the criteria of the PSFRM's Justification Test.



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