APPENDIX 9-1

FLOOD RISK ASSESSMENT REPORT

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Appendix 9-1 Flood Risk Assessment

1. Introduction

CDM Smith Ireland Ltd (CDM Smith) was requested by MKO, on behalf of Sheskin South Renewables Power Designated Activity Company (DAC), to complete a Preliminary Flood Risk Assessment (FRA) for the planning application for a proposed wind farm development (Proposed Development) at Sheskin, Co. Mayo.

The Proposed Development site covers an area of 1,189 hectares (ha), of which 24.22 ha represents the proposed permanent development footprint, *i.e.,* 2% of the total site area. The development comprises 21 no. turbines and associated works which are set out in Chapter 4 of the Environmental Impact Assessment Report (EIAR).

Topography slopes from west to east, from approximately 230 mOD at the western boundary to 100 mOD at the easter boundary. The catchment area of the Proposed Development is characterised in Chapter 9 (Hydrology and Hydrogeology) of the EIAR.

1.1 Purpose of Assessment

The purpose of this FRA is to determine and communicate whether the Proposed Development may cause a flood risk within or downgradient of the Proposed Development area. The FRA supplements Chapter 9 of the EIAR.

Flood risk can generally be expressed as:

Probability of Flooding x Consequences of Flooding

Accordingly, the FRA has considered both the catchment characteristics and the proposed drainage design in Appendix 4-4 (Drainage Design Drawings) and Appendix 9-3 (Drainage Design Calculations).

1.2 Statement of Authority

Established in Ireland since 2001, CDM Smith's ISO 9001, ISO 14001 and OHSAS 18001 - accredited Dublin office works on a diverse range of water and environmental projects for public and private sector clients, including the preparation of flood risk assessments associated with new developments.

This flood risk assessment (FRA) was prepared by Henning Moe (registered P. Geo.), a hydrogeologist with over 30 years of practical experience, and Jon Hunt (registered P. Geo.), a geologist with over 20 years of practical experience.

1.3 Methodology

This FRA was conducted in accordance with "The Planning System and Flood Risk Management Guidelines for Planning Authorities" (DEHLG/OPW, 2009). Per the guidance, Stage 1 of the FRA involves:

- Flood risk identification, to determine whether surface water flooding issues may be present at a site; and
- Initial flood risk assessment, to confirm sources of flooding that may affect a new development.

A Stage 2 FRA involves the confirmation of sources of flooding, appraising the adequacy of the available information and determining what surveys or other approaches (e.g., modelling) may be required for further assessment if a specific flood risk is identified.

The FRA presented in this appendix is a Stage 2 FRA. It has involved researching and collating flood-related information from the following public data and information sources:

- Office of Public Works (OPW) Flood Hazard Maps and flooding information for Ireland, available at www.floodmaps.ie.
- Catchment Flood Risk Assessment Management (CFRAM)/OPW Flood Risk Assessment Maps.
- Historical base maps from Ordnance Survey of Ireland (OSI).
- Geological Survey of Ireland (GSI) online map viewer.
- Environmental Protection Agency online map viewer.
- Site walkover and drainage observations.

OPW also published the Flood Risk Management Climate Change Sectoral Adaptation Plan in 2019 under the National Adaptation Framework and Climate Action Plan. The former outlines OPW's approach to climate change adaptation in terms of flood risk management. To account for projected climate change effects which are likely to worsen flooding and flood risk, OPW's plan presents two future flood risk scenarios to consider when assessing flood risk: a) a 'Mid-Range Future Scenario' (MRFS), and a 'High-End Future Scenario' (HEFS). For the purpose of this FRA, the Proposed Development was assessed in relation to the MRFS as a likely future scenario.

2. Flood Risk Identification

2.1 OPW Flood Incident Maps

The OPW's Past Flood Events mapping does not show any recurring flood incidents within the Proposed Development site or immediately downstream (**Figure 1**). The nearest historical flood incident was recorded on the Owenmore River at a location near Bangor Erris, where the river spilled over its banks on 12 July 1997 after 49.5 mm of rain had fallen in Bangor Erris over a 2-hour period. As presented in Chapter 9 of the EIAR, this equates to a 100-year rainfall event.

2.2 OPW River Flood Extents and Indicative Fluvial Flood Maps

OPW's National River Flood Extent Mapping[1] does not show any river flood extents within or downstream of the Proposed Development area. However, as reproduced in **Figure 1**, the National Indicative Fluvial Mapping[2] shows OPW-modelled "*low probability*" and "*medium probability*" fluvial flooding immediately east and downstream of Sheskin Forest, *i.e.,* outside the Proposed Development area boundary.

It is recognised that OPW's flood extent maps are modelled flood extents and not actual past, recorded flood extents. The OPW modelling is based on "*estimated probability of occurrence, rather than information for actual floods that have occurred in the past*." As stated by OPW on the Floodinfo website[3], "*Flooding from other reaches of river may occur, but has not been mapped, and so areas that are not shown as being within a flood extent may therefore be at risk of flooding from unmodelled rivers (as well as from other sources)*."

[1] Modelled extents of land that might be flooded by rivers (fluvial flooding) in a very extreme flood event, defined by: a) Low Probability flood events with an indicative 1-in-a-1000 chance of occurring or being exceeded in any given year. This is also referred to as an Annual Exceedance Probability (AEP) of 0.1%; b) Mid-Range Future Scenario extents which consider the potential effects of climate change using an increase in rainfall of 20% and sea level rise of 500mm (20 inches).

[2] Modelled extents of land that might be flooded by rivers (fluvial flooding) during a theoretical or 'design' flood event with an estimated probability of occurrence. Medium probability events are defined by AEP of 1% (or 100 year return period). Low probability events are defined by AEP of 0.1% (or 1000 year return periods).

[3] https://www.floodinfo.ie/map/floodmaps/ (last accessed 18 January 2023).

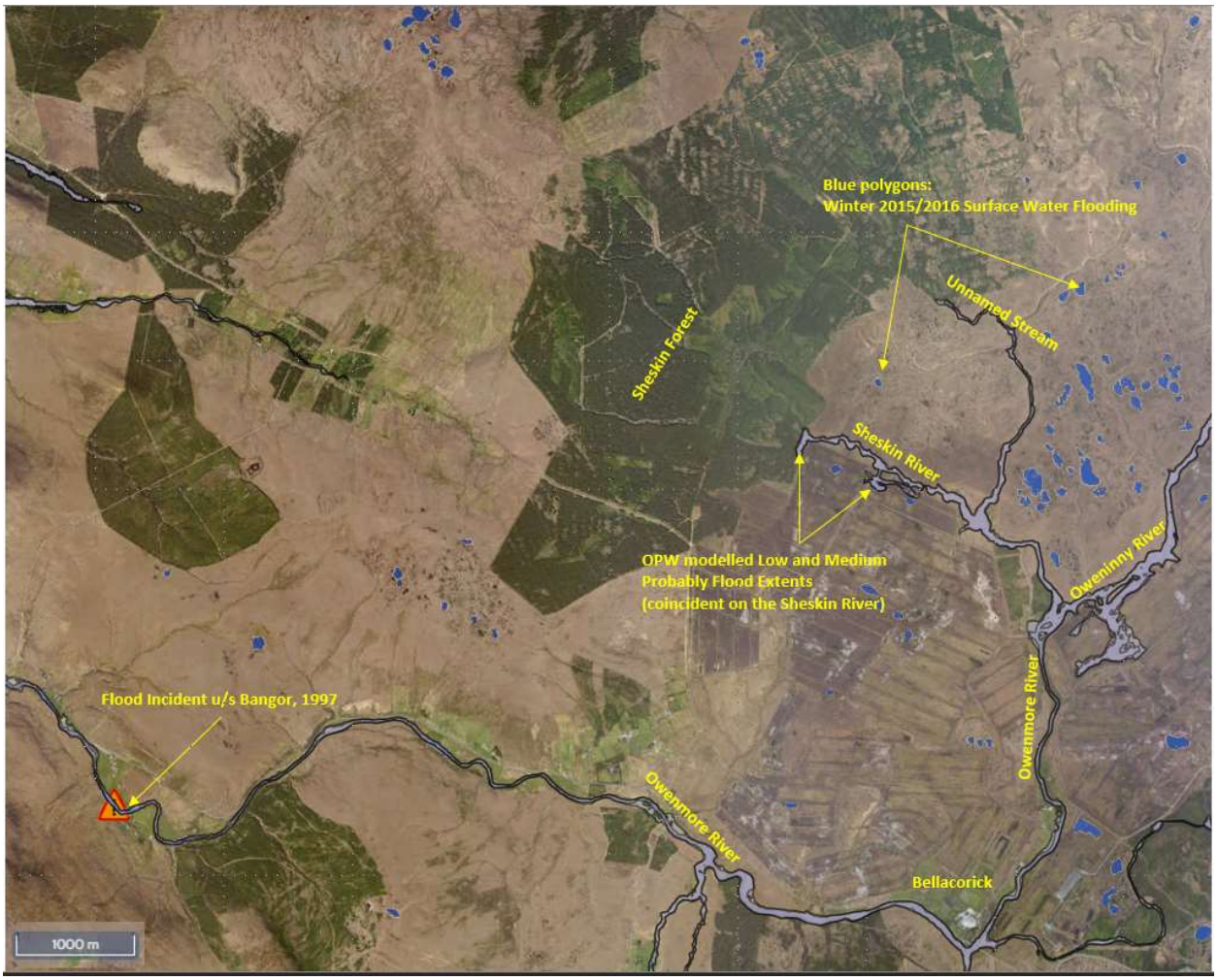

Figure 1: Flood Area Identification From OPW Mapping

That said, there are no records and were no visible signs noted (see below) of past flooding within the Proposed Development area. In combination, the OPW modelling and available other information indicates that the planned wind farm infrastructure is located in Flood Zone C (Low Risk).

2.3 Groundwater Flooding

Based on GSI's Groundwater Flooding Probability Mapping, there are no groundwater flood zones in the Proposed Development area or immediately downgradient.

2.4 Other Relevant Mapping

Historical Ordnance Survey Ireland (OSI) 6- and 25-inch mapping do not indicate locations that are "*prone to flooding*" within the Proposed Development area. However, the area between Sheskin Forest and the Oweninny/Owenmore Rivers is marked by low-gradient, boggy ground with numerous "rises" (i.e., seeps and springs) along the Sheskin River that naturally serve to maintain water-logged conditions on natural floodplains.

The GSI's 'Winter 2015/2016 Surface Water Flooding' map (**Figure 1**) shows ponded areas which reflect fluvial (rivers) and pluvial (rain) floods in Ireland during the winter 2015/2016 floods based on remote sensing imagery.[4] There was no flooding directly within the Proposed Development area but there was ponding (manifested as water logging) in flat-lying bog areas to the east of Sheskin Forest, which is a recurring winter occurrence. In the 2015/2016 winter season, the GSI has also recorded small ponding in the northwestern portion of Sheskin Forest, which reflects water collection in a small topographic basin.

2.5 Summary of Flood Risk Identification

The Proposed Development is located outside any fluvial flood zones (Flood Zones A-B). The planned infrastructure is situated at elevations which are higher than the OPW-modelled 1,000-year flood level, and will be situated higher than, and outside, 50 m buffer zones along water courses within Sheskin Forest. Hence, all of the planned infrastructure is situated in Flood Zone C (Low Risk), which is defined by a less than 0.1% probability of flooding.

3. Initial Flood Risk Assessment

Walkover surveys in Sheskin Forest were undertaken by CDM Smith in July 2021. Drainage conditions within the forest have not changed since then, hence the observation from July 2021 are considered representative of present-day.

The walkover surveys identified existing forestry drains as the primary drainage routes towards the natural streams within Sheskin Forest. The streams are small but the water courses are well defined in the landscape, with relatively steep slopes on either side. There was no evidence of out-of-bank flow from the various tributaries or forest drains.

As presented in Chapter 9 of the EIAR, mapped soil types in the Proposed Development area comprises blanket peat and smaller pockets of poorly drained mineral soils derived from glacial till. Alluvium sediments are only mapped along the Oweninny and Owenmore Rivers.

Several small streams within the Proposed Development area originate as headwater seeps or springs at higher ground within Sheskin Forest. These gradually merge in the downstream direction to form a) the Sheskin River, which drains the southern part of Sheskin Forest, and b) an unnamed stream which drains the northern part of the forest. In turn, the Sheskin River and the unnamed stream merge approximately 1.5 km downstream of the Proposed Development site boundary, and continue to flow as Sheskin River east to the Oweninny River, where flow continues as the Owenmore River to the south and turning west at Bellacorick.

Both the Sheskin River and unnamed stream are ungauged. However, as detailed in Chapter 9 of the EIAR, the estimated mean combined flow of the two water courses based on EPA's Qube model of streamflow in ungauged catchments is approximately 1.04 m^3/s. The sum of peak streamflows, represented by the 1-percentile flow, is 5.90 m^3/s.

Conceptually, the principal flood risk within the Proposed Development area is fluvial flooding resulting from overland flow (runoff) of rainwater, driven by the existing slopes. Runoff may be enhanced as the underlying bedrock is considered 'poorly productive', which means it has limited capacity to infiltrate or recharge all of the rainfall across the catchment.

Conceptually, fluvial flooding is manifested as overbank spills and fluvial flood risk increases in the downstream direction. In the case of Sheskin River, fluvial flood risk becomes relevant on the flatter terrain to the east of

[4] https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=848f83c85799436b808652f9c735b1cc

Sheskin Forest and outside the Proposed Development area, which is also indicated by OPW's modelled flood extent mapping (**Figure 1**).

Existing infrastructure east of Sheskin Forest comprises sparse houses/dwellings in the townland of Srahnakilly near the confluence of the Sheskin and Oweninny Rivers, and the secondary road which extends north from the N59 at the Bellacorrick power station, and which runs parallel to the south-flowing Owenmore River.

Within the Proposed Development area, the flood risk associated with planned infrastructure is low. All infrastructure (turbines, compounds, substation and borrow pits) are also deliberately situated at least 50 m from watercourses, by design. Only access roads will cross this 50 m buffer zone, and all water courses at bridge crossings will be culverted.

To the east and downstream of the Proposed Development area, the gentle/flat terrain is naturally water-logged/boggy. During wet weather events, the ground saturates from rainfall (pluvial flooding) as well as greenfield runoff from Sheskin Forest and water flow through the blanket peat.

As there will be no net change to the greenfield hydrological conditions in Sheskin Forest as a result of the Proposed Development, the Proposed Development will not influence the natural hydrological conditions of the floodplains of the Sheskin, Oweninny or downslope Owenmore Rivers**.**

4. Justification Tests

4.1 Vulnerability

The Planning System and Flood Risk Management Guidelines present flood risk in terms of flood zones A, B, and C, which correspond to areas of high, medium, or low probability of flooding, respectively. The extents of each flood zone are based on the Annual Exceedance Probability (AEP) of various flood events.

The referenced guidelines also categorise diverse types of development into three vulnerability classes based on their sensitivity to flooding. Because the Proposed Development consists of electricity-generating infrastructure, the development is considered a "Highly Vulnerable Development."

Table 1 below presents a decision matrix which indicates which types of development are appropriate in each flood zone and when the criteria of the 'Justification Test' included in the guidance document must be satisfied.

Table 1: Decision Matrix for Determining the Appropriateness of a Development

Flood Zone (Probability)	Annual Exceedance Probability (AEP)	Development Appropriateness		
		Highly Vulnerable	Less Vulnerable	Water Compatible
A (High)	Fluvial & Pluvial Flooding More frequent than 1% AEP	Justification Test	Justification Test	Appropriate
	Coastal Flooding More frequent than 0.5% AEP			
B (Medium)	Fluvial & Pluvial Flooding 0.1% to 1% AEP	Justification Test	Appropriate	Appropriate
	Coastal Flooding 0.1% to 0.5% AEP			
C (Low)	Fluvial, Pluvial & Coastal Flooding Less frequent than 0.1% AEP	Appropriate	Appropriate	Appropriate

The Proposed Development site is located entirely outside a mapped flood zone A or B. The location of the electrical substation is also at a higher elevation than the Low Probability event and MRFS level. For this reason, the Proposed Development is considered "appropriate" from a flood risk perspective and the justification does not need to be applied.

4.2 Planning Policy

Chapter 11 of Mayo County Council's (MCC) County Development Plan (2022-2028) incorporates several supporting statements for wind energy development (MCC, 2022). The council's Renewable Energy Strategy (RES) also includes maps that identify "priority" and "preferred" areas for wind farm development, as well as "locations open for consideration" (MCC, 2011).

The county development plan specifically states that "The Council will endeavour to continue to facilitate wind energy projects that accord with the Mayo RES, the Landscape Appraisal of County Mayo and relevant Section 28 ministerial guidelines". Furthermore, the county's rural energy policy #7 is "To promote the harnessing of wind energy to contribute toward decarbonising County Mayo, including new emerging by-product markets".

With regard to flood risk, the county development plan incorporates a Strategic Flood Risk Assessment (SFRA) which includes mapped boundaries for indicative flood risk zones that account for factors such as local knowledge, site walkovers and flood risk indicators. Neither the Proposed Development nor downstream areas feature in the county SFRA.

However, the SFRA contains numerous principles and policies which have been factored into the proposed drainage design for the Proposed Development. For example, MCC advocates surface water management through Sustainable Urban Drainage Systems (SuDS) to minimise the effects on flooding and pollution of water courses through engineering solutions, including ponds, swales, filter drains or other installations.

In the context of flood risk, the county SFRA sets the following surface water objectives (SWOs):

- SWO 16: "To support, promote and facilitate the use of green infrastructure …. in the interests of flood mitigation….."
- SWO 17: "To require the use of SuDS …. to reduce the potential impact of existing and predicted flooding risks."
- SWO 18: "To ensure new development is adequately serviced with surface water drainage infrastructure, which meets the requirements of the Water Framework Directive, associated River Basin Management Plans and Catchment Flood Risk Assessment Management (CFRAM) Plans".

The Proposed Development and the associated drainage design are consistent with these requirements. Many of the proposed drainage solutions are SuDS-based and SuDS-compatible, and the referenced plans have been included in the overall assessment of likely significant effects.

Specific, relevant SFRA objectives which are included in the county SFRA are summarised in **Table 2**, along with notes on how the planning application addresses the objectives.

Table 2: County Mayo SFRA Objectives and Responses in Planning Application

Objective No.	SFRA Objective	Response in Planning Application
19	*"To ensure that a flood risk assessment is carried out for any development proposal where a flood risk is identified in accordance with the Planning System and Flood Risk*	A Stage 2 FRA was conducted based on the DEHLG Guidelines document and OPW flood risk mapping.

Objective No.	SFRA Objective	Response in Planning Application
	Management (DEHLG/OPW 2009) and Circular PL2/2014. This assessment shall be appropriate to the scale and nature of risk to the potential development."	
20	*"To consult with the OPW in relation to proposed developments in the vicinity of drainage channels and rivers for which the OPW are responsible and retain a strip on either side of such channels where required, to facilitate maintenance access thereto."*	The proposed drainage design includes a 50 m buffer assigned to each water course, within which infrastructure, including discharges, will be avoided.
22	*"To protect the integrity of any formal (OPW or Mayo County Council) flood risk management infrastructure, thereby ensuring that any new development does not negatively impact any existing defence infrastructure or compromise any proposed new infrastructure."*	Checks were conducted and found to be not applicable in this instance.
23	*"To ensure that where flood risk management works take place that natural heritage, cultural heritage, rivers, streams and watercourses are appropriately protected."*	This was considered in the proposed drainage design.
24	*"To consult, where necessary, with Inland Fisheries Ireland, the National Parks and Wildlife Service and other relevant agencies in the provision of flood alleviation measures in the County."*	Responses of statutory consultees were considered.
25	*"To ensure each flood risk management activity is examined to determine actions required to embed and provide for effective climate change adaptation as set out in the OPW Climate Change Sectoral Adaptation Plan Flood Risk Management applicable at the time."*	Climate change effect (increased rainfall) was considered in the proposed drainage design.
27	*"To identify and preserve vulnerable floodplains, wetlands and coastal areas to the maximum possible extent in both urban and rural areas."*	Not applicable in this instance.

5. Summary of Proposed Drainage System

The proposed drainage system has been integrated with the existing drainage system which serves the Sheskin Forest operations to date. The proposed drainage system will not change the existing hydrological conditions within the Proposed Development site, but some of the runoff water will be redirected and/or discharged diffusely uses level spreaders or via new settlement ponds. There will be no direct discharges to water courses. Instead, water will be discharged in controlled/managed manners, by spreading out across open ground to discharge at greenfield runoff rates. A 50 m buffer along all water courses will be maintained during construction which will serve to limit sediment transport to streams.

Upstream of new infrastructure components, e.g., turbines and their hardstanding, greenfield runoff will be intercepted to bypass works areas. In working areas and downslope of roads, 'dirty water' will be intercepted via swales and directed to dedicated settlement ponds for removal of suspended solids prior to controlled discharge as indicated above.

Streams intercepted by access roads will be crossed by clear-span culverts. The culverts will be designed to accommodate 100-year flood events. Grid cables which traverse streams will be passed across the culverts or through horizontal borings beneath streambeds, depending on location-specific conditions.

Flow along interceptor drains upslope of access roads and swales downslope of works areas will be buffered with check dams at regular intervals to help break the energy of flow, settle out any suspended sediments, and reduce sediment load to streams. Spacing of such dams will depend on slope, but will generally be every 50 m (or less)

depending on slope. Discharges will be dispersed across vegetation and dilute with greenfield runoff as stated above.

The Proposed Development is divided into subcatchments for each infrastructure component and segment of access road between streams. The runoff associated with each subcatchment is calculated and serves to guide the placement of settlement ponds. The settlement ponds will be dimensioned to provide temporary storage for runoff that is defined by 6-hour duration, 10-year return storm events.

6. Summary of FRA

The flood risk associated with the Proposed Development is low. This is mainly because of the topographic characteristics, including slopes, of the Proposed Development area. During walkover surveys, there was no visible evidence of flooding within the surveyed sections of Sheskin Forest. The Proposed Development and its associated drainage system will not increase or otherwise change fluvial flood risk within or downstream of Sheskin Forest. The proposed drainage system will serve to control discharges of runoff waters to streams at greenfield runoff rates using a combination of interceptor drains, check dams, swales, settlement ponds, and buffered, disperse outfalls. The majority of discharges will be outside a 50 m buffer zone along all water courses..

There is limited infrastructure present downgradient of the Proposed Development. The Proposed Development is compatible with the objectives of the County Mayo Development Plan (2022-2028) and the county-wide SFRA.

7. References

DEHLG/OPW (2009). The Planning System and Flood Risk Management. Guidelines for Planning Authorities. November 2009. Accessible from: https://www.opr.ie/wp-content/uploads/2019/08/2009-Planning-System-Flood-Risk-Mgmt-1.pdf

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