APPENDIX 9-1

FLOOD RISK ASSESSMENT

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LEMANAGHAN WIND FARM, CO. OFFALY

STAGE III - SITE SPECIFIC FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:

LEMANAGHAN WIND FARM DAC

Prepared by:
Hydro-Environmental Services

DOCUMENT INFORMATION

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This report has been prepared by HES with all reasonable skill, care and diligence within the terms of the contract with the client, incorporating our terms and conditions and taking account of the resources devoted to it by agreement with the client. We disclaim any responsibility to the client, and others in respect of any matters outside the scope of the above. The flood risk assessment undertaken as part of this study is site-specific, and the report findings cannot be applied to other sites outside of the survey area which is defined by the site boundary. This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies upon the report at their own risk.

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1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) were requested by MKO Ireland (MKO), on behalf of Lemanaghan Wind Farm DAC (the Applicant), to undertake a site-specific Flood Risk Assessment (SSFRA) for the Proposed Project (i.e. the proposed Lemanaghan Wind Farm).

The Proposed Project is described in full in Chapter 4 of the Environmental Impact Assessment Report (EIAR). The Proposed Project encompasses the Proposed Wind Farm and the Proposed Grid Connection. The Proposed Project site relates to the primary study area for the EIAR.

Lemanaghan Bog forms part of the larger Boora Bog Group, a suite of bogs situated around the central Boora Bog. These bogs are located between the towns of Birr and Tullamore, Co. Offaly. Lemanaghan Bog is a Bord na Móna (BnM) peat bog, and as a result of previous peat extraction is extensively modified and drained.

This SSFRA is carried out in accordance with '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*' (DoEHLG, 2009) (hereinafter referred to as the Guidelines (DoEHLG, 2009)). This FRA is also completed in accordance with the Flood Risk Management policies (CAEP-53 to CAEP-63) and the policies in relation to Peatlands (CAEP-16 to CAEP20) detailed in the Offaly County Development Plan (2021-2027).

1.2 STATEMENT OF AUTHORITY

Hydro-Environmental Services ("HES") are a specialist geological, hydrological, hydrogeological and environmental practice which delivers a range of water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core area of expertise and experience is hydrology and hydrogeology, including flooding assessment and surface water modelling. We routinely work on surface water monitoring and modelling, and prepare flood risk assessment reports.

Michael Gill (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 23 years' environmental consultancy experience in Ireland. Michael has completed numerous geological, hydrological and hydrogeological impact assessments of wind farms and renewable projects on peatlands in Ireland. He has substantial experience in surface water drainage design and SUDs design, flood modelling, and surface water/groundwater interactions. For example, Michael has worked on the EIS for Carrownagowan WF, Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm-related projects.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with over 5 years' experience in environmental consultancy in Ireland. Conor holds an M.Sc. in Applied Environmental Science (2020) and a B.Sc. in Geology (2016) from University College Dublin. Conor has prepared the Land, Soils and Geology and Hydrology and Hydrogeology Chapters for numerous wind farm EIAR projects. Conor routinely completes Flood Risk Assessments for a wide variety of projects including wind farms, quarries and proposed residential developments.

Nitesh Dalal (B.Tech, PG Dip., MSc) is an Environmental Scientist with over 7 years' experience in environmental consultancy and environmental management in India. Nitesh holds a M.Sc. in Environmental Science from University College Dublin (2024), a PG Diploma in Health, Safety and Environment from Annamalai University, India (2021) and B.Tech. in Environmental Engineering (2016) from Guru Gobind Singh Indraprastha University, India (2016).

1.3 REPORT LAYOUT

This SSFRA report has the following format:

- Section 2 describes the setting of the Proposed Project site and details of the Proposed Project;
- Section 3 details the hydrological and geological characteristics of the local area;
- Section 4 deals with a site-specific flood risk assessment (FRA) undertaken for the Proposed Project which was carried out in accordance with the above-mentioned guidelines. This section includes a detailed assessment of the flood risk at the Proposed Project site and also determines whether a Justification Test is required for the Proposed Project;
- Section 5 presents the proposed drainage system which will be implemented on-site as part of the Proposed Project. This section discusses the potential impact that the Proposed Project may have on the downstream flood risk;
- Section 6 presents the Justification Test for the Proposed Project; and,
- Section 7 presents the SSFRA report conclusions.

2. BACKGROUND INFORMATION

This section provides details on the topographical setting of the Proposed Project site along with a description of the Proposed Project.

2.1 SITE LOCATION AND TOPOGRAPHY

The Proposed Project site is located at Lemanaghan Bog, a large BnM bog which forms part of the wider Boora Bog Group. The Proposed Project site, which includes both the Proposed Wind Farm and the Proposed Grid Connection, comprises an area of 1,258hectares (ha). Industrial peat extraction activities commenced at the Proposed Project site in 1950 with site preparation works (drainage and removal of vegetation) followed by the commencement of peat extraction from 1960; industrial peat extraction ceased at Lemanaghan Bog in June 2020.

The Proposed Project site is located approximately 3km to the northeast of Ferbane and 2.5km southwest of the village of Ballycumber in Co. Offaly. The Proposed Wind Farm extends across several townlands which are listed in Table 1-1 of Chapter 1. The Proposed Wind Farm measures approximately 5.5km in length from north to south, and approximately 6.9km from east to west, at its widest point. Grid Reference co-ordinates for the approximate centre of the Proposed Project site are X616027, Y728163 (ITM).

The Proposed Wind Farm is connected by rail link to the Bellair South Bog to the north and to the Blackwater Bog Group to the west. The R436 Regional Road passes along much of the southern boundary of the Proposed Wind Farm with Derrynagun and Curraghalassa bogs located to the south of the R436 regional road. The N62 National Road skirts the extreme western tip of the Proposed Wind Farm. The L7002 local road passes through the northern part of the Proposed Wind Farm and the L7001 runs to the north of the Proposed Grid Connection. The Proposed Wind Farm is accessed via an existing entrance off the N62 National Road and 1 no. existing entrances along the R436 into the south of the Proposed Project site. Please see Table 4-9 in Chapter 4 for further detail on site entrances.

The current topography of the Proposed Wind Farm is relatively flat with an elevation range of between approximately 50 and 62mOD (metres above Ordnance Datum). Topography at the Proposed Wind Farm has been modified through industrial peat extraction activities and all ancillary works including associated drainage works. Today the highest elevations are found at headlands and remnant peat banks which create a boundary berm, forming a basin effect within the former extraction areas of the bog. These remnant peat banks and headlands provide an approximation (albeit drained and subsided) of the original ground elevations which existed across the Proposed Wind Farm prior to the commencement of any peat extraction activities.

Note that as part of the Proposed Project, turbine accommodation works will be required as Kennedys Cross, located in the townland of Ballindown, Co. Offaly at the junction of the N52 and N62.

A site location map is shown as **Figure A.**

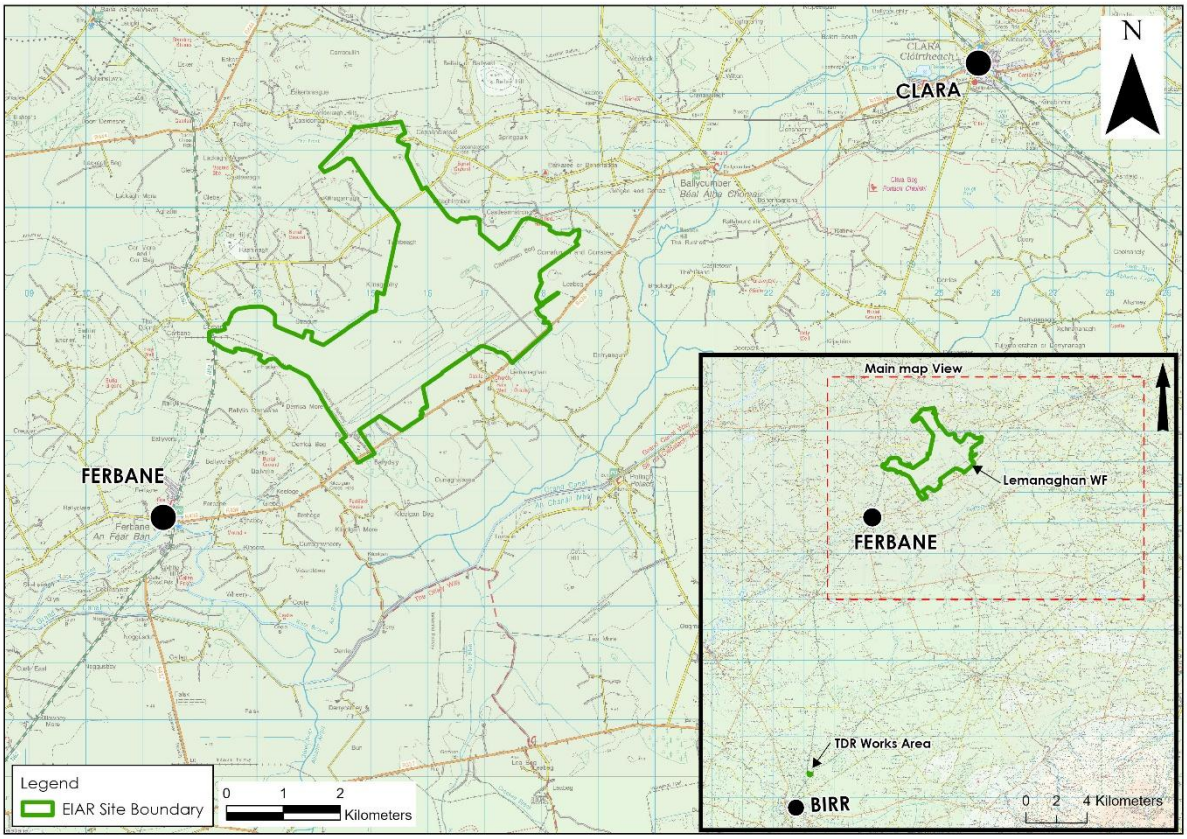

Figure A: Site Location Map

2.2 PROPOSED PROJECT DETAILS

The Proposed Wind Farm consists of 15 no. wind turbines and associated infrastructure including hardstands, 1 no. meteorological mast, 5 no. temporary construction compounds, 4 no. borrow pits, 3 no. permanent amenity carparks, approximately 16.9km of new road, the upgrade of approximately 1.14km of existing road, the construction of approximately 03.9km of dedicated new amenity track, the upgrade of approximately 1.8km of existing road for the purposes of amenity, felling of immature woodland (1.02ha), proposed biodiversity enhancement and mitigation measures, and all associated development and drainage works.

The Proposed Grid Connection comprises of a 220kV electricity substation, control buildings, approximately 0.8km of overhead line, 4 no. new steel masts, 2 no. gantry structures, telecommunications tower and 0.3km of temporary access track.

Please refer to Chapter 4 of the EIAR for a full description of the Proposed Project.

3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTICS

This section gives an overview of the hydrological and geological characteristics within the Proposed Project site and in the surrounding lands.

3.1 BASELINE HYDROLOGY

3.1.1 Regional and Local Hydrology

Regionally, the Proposed Project site is located in a total of 3 no. surface water catchments. The vast majority of the Proposed Project site is located in the Lower Shannon surface water catchment within Hydrometric Area 25A of the Shannon Irish River Basin District (Shannon IRBD). A small area in the northwest of the Proposed Project site is located within the Lower Shannon surface water catchment within Hydrometric Area 25B of the Shannon IRBD. Furthermore, a small section towards the north of the Proposed Project site is located in the Upper Shannon surface water catchment within Hydrometric Area 26G of the Shannon IRBD (www.epa.ie). Therefore, all surface waters draining the Proposed Project site will eventually discharge to the River Shannon. The River Shannon flows to the southwest approximately 10km northwest of the Proposed Project site before veering to the southeast at Shannonbridge, approximately 15km west of the Proposed Project site. The River Shannon then flows to the southwest, north of Banagher, approximately 17km southwest of the Proposed Project site before eventually discharging into Lough Derg.

Within the Upper Shannon regional surface water catchment (26G), the Proposed Project site is located in the Shannon Lower sub-catchment (Shannon[Lower]_SC_010) and the Boor_010 WFD river sub-basin. This area of the Proposed Project site is drained by the Boor River. Within this WFD river sub-basin the EPA named the Ballynahown Stream (EPA Code: 26B17) flows to the northwest from the vicinity of the Proposed Project site. For reference, this stream is referred to locally on the 25" basemaps and on the Discovery Series Maps as 'The Brook'. The Brook Stream discharges into the Boor River (EPA Code: 26B07) approximately 6.5km northwest of the Proposed Project site. The Boor River the continues to the west for 4.5km before it discharges into the River Shannon (EPA Code: 26S02).

Within the Lower Shannon (25B) regional surface water catchment, the Proposed Project site is located in the Shannon Lower sub-catchment (Shannon[Lower]_SC_030) and the Blackwater(Shannonbridge)_010 WFD river sub-basin. The closest EPA mapped watercourse is the EPA named Holy Well of Clongawny Stream (EPA Code: 25H29) which flows to the northwest approximately 950m west of the Proposed Project site and discharges into the Blackwater River (EPA Code: 25B27) approximately 3.3km northwest of the Proposed Project site. The Blackwater River then continues to the southwest before discharging into the Lower River Shannon (EPA Code: 25S01) approximately 13.5km southwest of the Proposed Project site and southeast of the village of Shannonbridge.

As stated above, the majority of the Proposed Project site is located within the Lower Shannon (25A) regional surface water catchment. On a more local scale within this catchment, the Proposed Project site is situated in the River Brosna sub-catchment (Brosna_SC_060) and 3 no. WFD river sub-basins. The easternmost section of this area of the Proposed Project site is located in the Brosna_100 WFD river sub-basin. In this area the EPA named Fortified House Castlearmstrong Stream (EPA Code: 26F69) flows southwards immediately to the east of the Proposed Project site. This stream discharge into the Brosna River (EPA Code: 25B09) approximately 1.3km to the east. Meanwhile, the majority of the Proposed Project site is located in the Lemanaghan Stream_010 WFD river sub-basin with the Lemanaghan Stream (EPA Code: 25L04) flowing southwards through the centre of the Proposed Project site. This stream discharges into the Brosna River approximately 1.2km south of the Proposed Project site. Within this WFD river sub-basin the EPA map another stream to flow to the southwest along

the northern boundary of Derrynagun Bog. This stream, referred to by the EPA as the Lemanaghan (EPA Code: 25L72) discharges into the Lemanaghan Stream to the south of the Proposed Project site. In addition, the west of the Proposed Project site is located in the Brosna_110 WFD river sub-basin. Here the EPA named Kilcolgan Beg Stream (EPA Code: 25Q21) flows to the south from the Proposed Project site, passing to the west of Curraghalassa Bog discharging into the Brosna River.

Downstream of the Proposed Project site the Brosna River then continues to flow to the west before it discharges into the Lower River Shannon approximately 14.5km to the southwest. The River Shannon itself then continues to flow to the southwest before discharging into Lough Derg near Portumna.

A hydrology map of the Site is shown as **Figure B** below.

3.1.2 Existing Site Drainage

Due to the historic industrial peat extraction activities at the Proposed Project site, the site has been artificially drained in order to lower the peat water table. Drainage ditches were first inserted into the upper surface of the bog in 1950 prior to the commencement of peat extraction in 1960.

Currently surface water (or runoff water) is drained from the site via a network of field drains typically spaced at 15 to 20m intervals, piped drains, main drains, headland drains, and silt ponds. Much of the site is drained by gravity however there are 2 no. existing pumps located in the centre of the site. Following peat extraction activities, drainage by gravity in this area of the site was no longer feasible as the water level in the surrounding streams were higher than the water level within the site. The field drains discharge to main drains which flow via gravity towards the perimeter of the site where they discharge to larger headland drains. These headland drains eventually discharge to large silt (settlement) ponds (9 no.) (refer to **Table A** below). The silt ponds are used to trap sediment and prevent elevated levels of suspended sediment arising in effluent from the drained peatland. Treated surface water is then discharged at outfall points where the effluent flows into off-site drainage channels which in turn discharge into the local stream and river network.

The drainage of Lemanaghan Bog, in which the majority of the Proposed Project site is located, is currently operating under licence from the EPA (P0500-01). The drainage system has been operating in accordance with this existing Integrated Pollution Control (IPC) licence, with all drainage water from the bogs being discharged via an appropriately designed silt pond treatment arrangement.

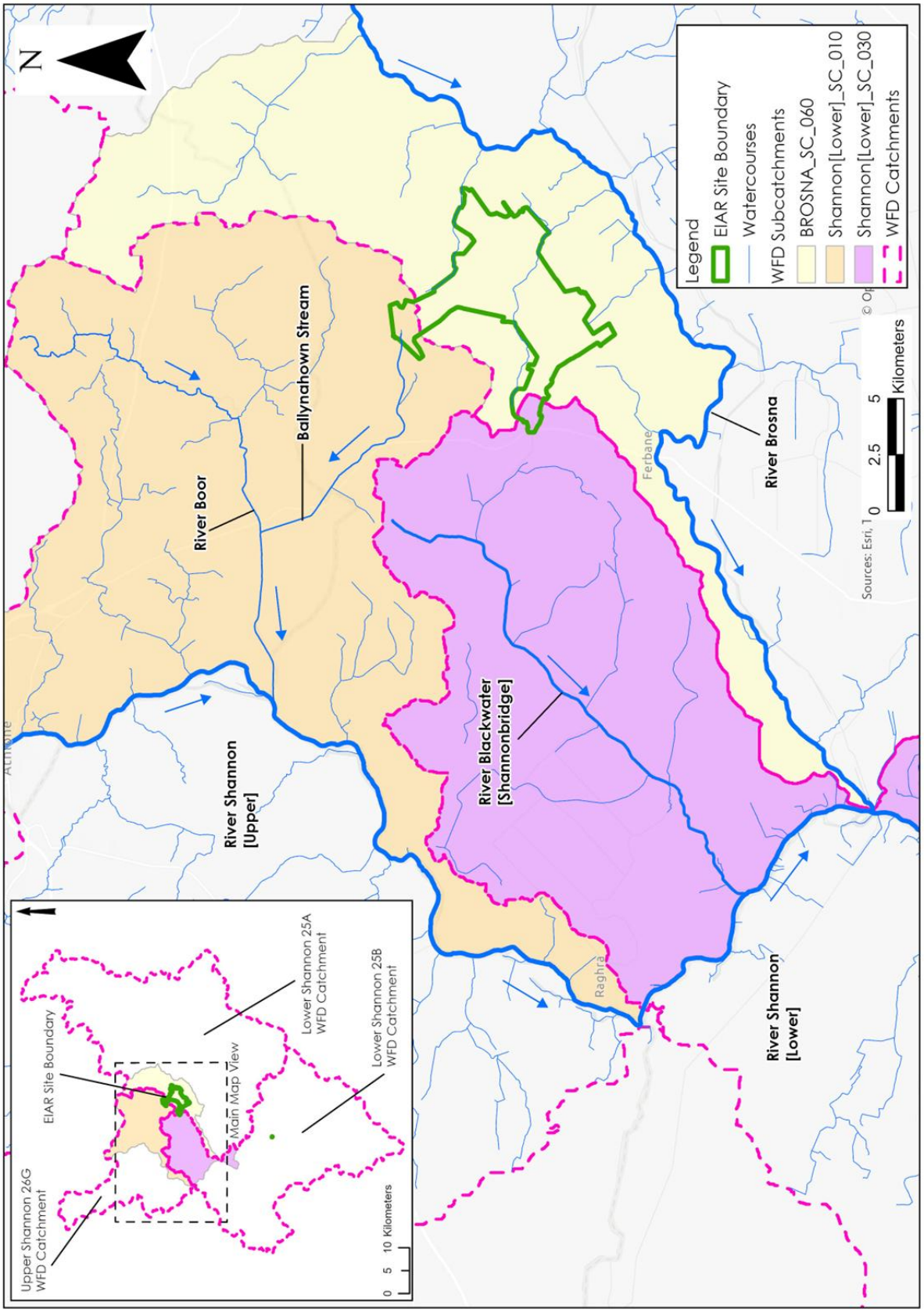

Figure B: Local Hydrology Map

A flow diagram for the existing drainage system is shown as **Figure C** below.

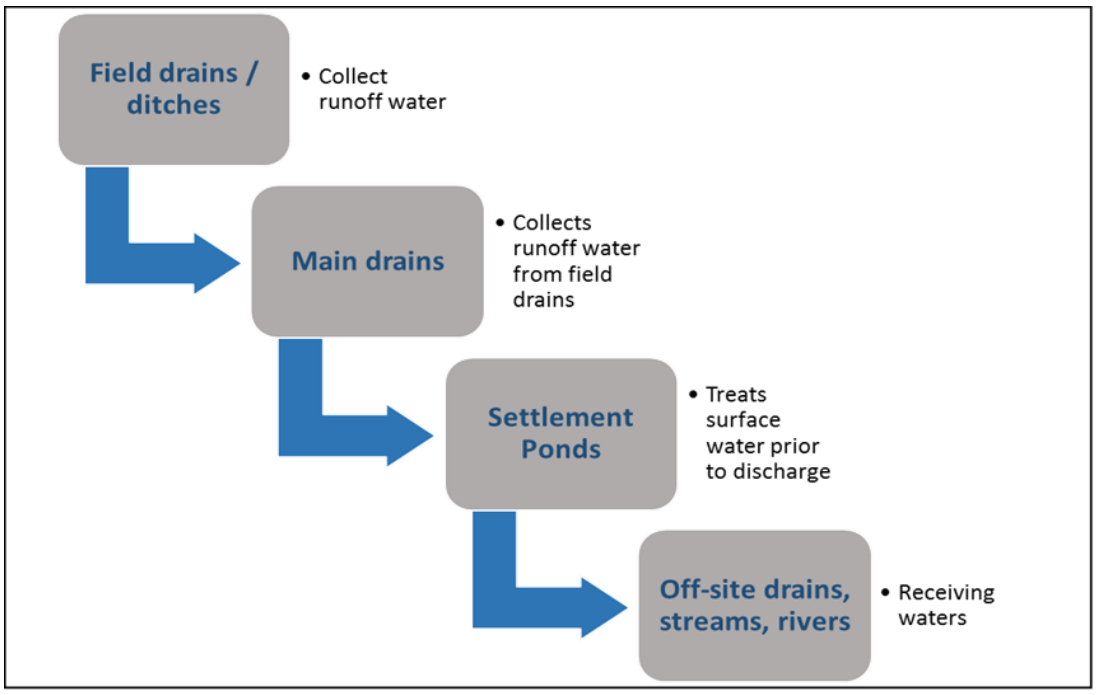

Figure C: Process Flow Diagram for the Existing Site Drainage System

A detailed hydrological audit of flowpaths for the Proposed Project site to its eventual discharge point at the regional catchment scale was completed.

Drainage from the Proposed Project site discharges through 8 no. gravity surface water outfalls (SW19, SW19A, SW19B, SW22, SW22A, SW22B, SW22C and SW22D).

- In the east of the Proposed Project site, within the Brosna_100 WFD river sub-basin, there are a total of 4 no. discharge points (SW22, SW22A, SW22B and SW22C) to the EPA named Fortified House Castlearmstong Stream;
- Within the Boor_020 WFD river sub-basin, there is 1 no. outfall (SW22D) to the EPA named Ballynahown Stream (referred to locally as the Brooks Stream);
- Within the Lemanaghan Stream_010 WFD river sub-basin, there are a total of 2 no. outfalls (SW19 and SW19A) to the EPA named Lemanaghan Stream; and,
- To the west, within the Brosna_110 WFD river sub-basin, there is 1 no. outfall (SW19B) to the EPA named Kilcolgan Beg Stream, a tributary of the Brosna River.

Note that despite a section of the Proposed Project site being mapped in the catchment of the Blackwater River, there are no surface water discharge points (outfalls) within this sub-catchment. Drainage in this area of the Proposed Project site is directed, via field and main drains, into the Brosna sub-catchment and discharges to the tributaries of the Brosna River.

The respective settlement ponds and their outfall pipe elevations are presented in **Table A** below. Outfall pipe elevations range from 44.59 – 52.23mOD (metres above Ordnance Datum) with the greatest outfall elevations recorded in the north of the Proposed Project site at SW22D. Outfalls generally discharge to nearby surface water bodies as mapped by the EPA or into smaller drains that flow towards these mapped watercourses.

There are 8 no. gravity flow surface water outflows and, associated silt ponds, in the Proposed Project site. There is also a central area of the bog drained by existing pumps P15-03 and P15-04 and this pumped outfall flows through a series of silt ponds before discharging through SW19. 7 of the 8 no. outfalls discharge into tributaries of the Brosna River whilst, SW22D in the north, discharges into the Ballynahown Stream, a tributary of the Boor River. Outfalls generally

discharge to nearby surface water bodies as mapped by the EPA or into smaller drains that flow towards these mapped watercourses (refer to **Figure D**).

The above text relates to the drainage within Lemanaghan Bog, which comprises of the vast majority of the Proposed Project site. However, several elements of the Proposed Grid Connection and the TDR works area are located outside of Lemanaghan Bog, and are therefore not drained by the manmade bog drainage system (field drains, main drains, settlement ponds and outfalls) as described above. The Proposed Grid Connection infrastructure under the existing OHL (i.e., 2 no. steel masts and temporary access road) are located within agricultural pastures to the north of the bog. During the walkover surveys drainage was noted to be modified in this area with a series of manmade agricultural drains. No significant drainage features are present at the TDR accommodation works area at Kennedy's Cross.

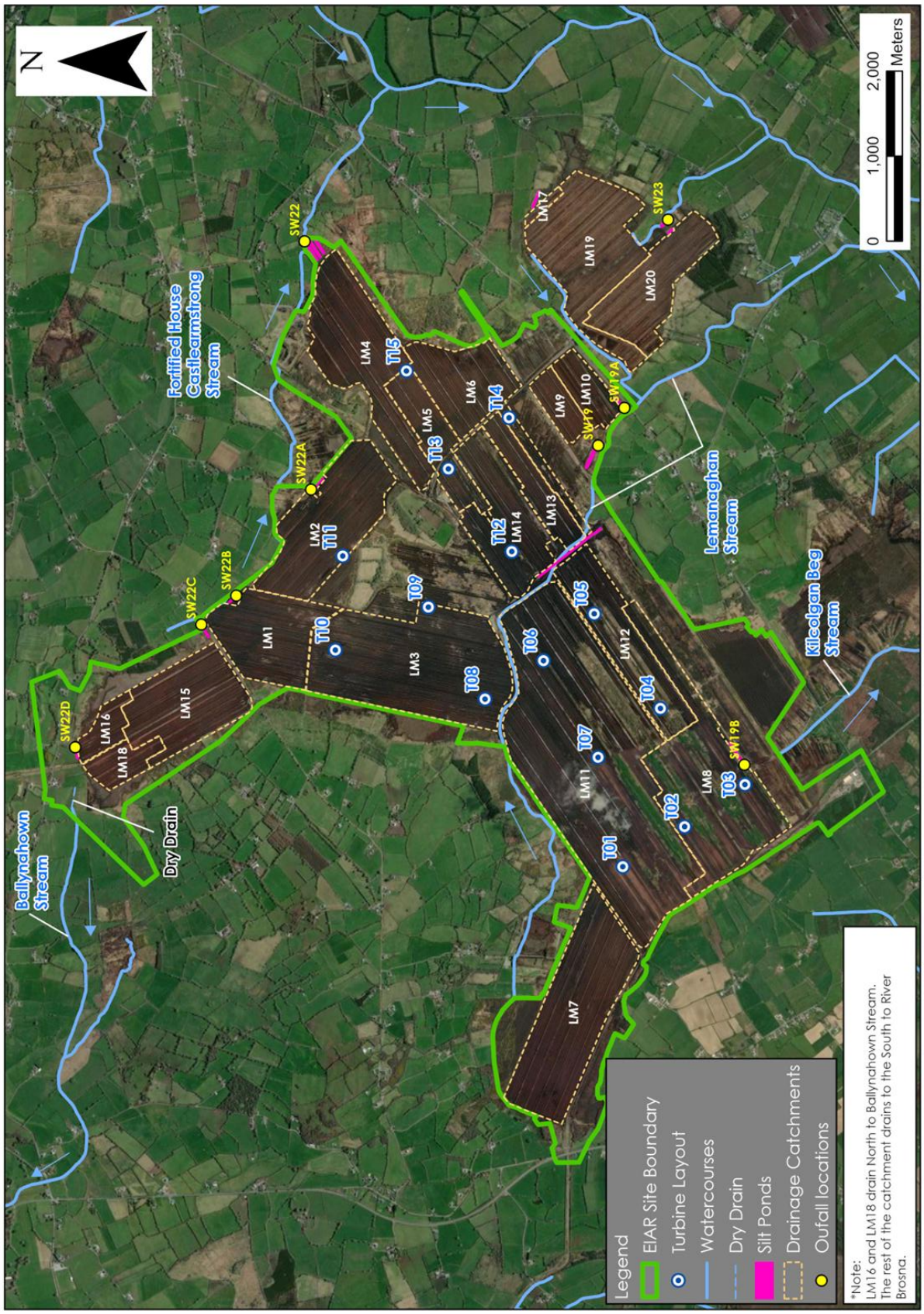

Figure D: Drainage and Outfall Map

Table A: BnM outfall elevations

Settlement Pond ID	Easting	Northing	Outfall Pipe Elevation (m OD)	Nearby Surface Watercourse (EPA Name)	Distance from Outfall to Watercourse (m)
SW22D	614848	731164	53.24	The Brooks Stream	200
SW22C	615893	730342	52.23	Castlearmstrong Stream	100
SW22B	616097	730096	51.22	Castlearmstrong Stream	50
SW22A	616846	729572	48.07	Castlearmstrong Stream	200
SW22	618591	729624	44.59	Castlearmstrong Stream	Direct discharge to watercourse
SW23	618754	727069	45.56	Derrynagun Stream	Direct discharge to watercourse
SW19	617162	727554	Not available	Lemanaghan Stream	40
SW19A	617427	727372	45.98	Lemanaghan Stream	Direct discharge to watercourse
SW19B	614916	726519	46.13	Kilcolgan Beg Stream	280

3.1.3 Rainfall and Evaporation

Met Éireann provide a grid of AAR for the entire country for the period of 1991 to 2020. Based on this the 30-year AAR (1991-2020) assigned to location E216000, N228000 (close to the centre of the Proposed Project site) is 914mm/yr. The average potential evapotranspiration (PE) at Birr, ~22km south of the Proposed Project site, is 444.9mm/year (www.met.ie). The actual evapotranspiration ("AE") is calculated to be 422.7mm (95% PE). Using the above figures the effective rainfall ("ER")[1] for the area is calculated to be (ER = SAAR – AE) 491.3mm.

Based on recharge coefficient estimates from the GSI (www.gsi.ie), an estimate of 4% recharge is taken for the Site as an overall average. This value is for "Peat" with a "High" vulnerability rating. Areas where peat is absent may have slightly higher recharge rates, but on this site, these areas are generally very small and localised. The high drainage density in the area would also suggest that groundwater recharge rates are very low.

The lowest value in the available range was chosen to reflect the large coverage of blanket peat and high drainage density. Therefore, annual recharge and runoff rates for the site are estimated to be 19.65mm/year and 471.65mm/year respectively.

Table B below presents return period rainfall depths for the area of the Proposed Project site. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (1-year, 5-year, 30-year, 100-year, and 500-yr). These extreme rainfall depths will be the basis of the proposed wind farm drainage hydraulic design as described further below.

[1] *ER – Effective Rainfall is the excess rainfall after evaporation which produces overland flow and recharge to groundwater.*

Table B: Rainfall Return Period Depths for Lemanaghan Bog

	Return Period (Years)				
Duration	**1**	**5**	**30**	**100**	**500**
5 mins	3.9	6.6	11.3	15.8	n/a*
15 mins	6.3	10.8	18.5	25.9	n/a
30 mins	8.0	13.2	22.0	30.3	n/a
1 hour	10.2	16.3	26.3	35.4	n/a
6 hours	18.8	27.8	41.3	52.8	n/a
12 hours	23.9	34.1	49.2	61.7	n/a
24 hours	30.3	42.0	58.6	72.1	94.7
2 days	38.1	50.8	68.2	81.9	104.2

* n/a – data not available

3.2 SOILS AND SUBSOILS

The published Teagasc soils map (www.gsi.ie) for the local area shows that the Proposed Project site is mapped to be almost exclusively overlain by cutover/cutaway peat. There are some very small, localised pockets of mainly basic peaty poorly drained mineral soils (BminPDPT) and basic poorly drained mineral soils (BminPD) mapped within the Proposed Project site. Soils mapped in the surrounding lands comprise largely of basic deep well drained mineral soil (BminDW) to the north and west, basic shallow well drained mineral soil (BminSW) to the east and cutover peat to the south. Mineral alluvium (AlluvMIN) is mapped along many of the local watercourses in the surrounding lands, with significant alluvium deposition along the Brosna River to the south and east of the Proposed Wind Farm.

The published GSI subsoils map (www.gsi.ie) shows that the Proposed Project site is underlain predominantly by cut over raised peat (Cut). The GSI also map some small, isolated pockets of gravels derived from limestone (GLs) and till derived from limestones (TLs). The island of agricultural land surrounded by Lemanaghan Bog is mapped to be underlain by tills derived from limestones (TLs) and bedrock outcrop or subcrop (Rck). Subsoils in the surrounding lands are mapped largely as cutover peat and tills derived from limestone and gravels derived from limestone. Some esker sands and gravels are also mapped to the northeast. Alluvium subsoils are mapped ~1.5km to the south of the Proposed Project site and 400m to the east along the Brosna River and its tributaries. An area of lake marl (Mrl) is also mapped approximately 700m to the southeast in the townland of Derrynagun.

The soils and subsoils present at the Proposed Project site have been verified during site walkover surveys and intrusive site investigations. The results of these site investigations are detailed in Chapter 8 of the EIAR.

3.3 BEDROCK GEOLOGY

The bedrock geology of the local area is characterised by the presence of a large anticlinal structure, known as the Ferbane Inlier. Devonian Kiltorcan-type Sandstones of this body form the core of this major northeast southwest trending anticlinal structure. The sandstones are overlain to the northwest and southeast by Dinantian Sandstones, Shales and Limestones which are in turn overlain by Dinantian Lower Impure Limestones.

The anticlinal fold axis of the Ferbane Inlier is mapped underlying the south of the Proposed Project site. Here the GSI maps the presence of the Devonian Old Red Sandstones (Devonian Kiltorcan-type sandstones) which form the core of this anticline structure and are comprised of red conglomerates, sandstones and mudstones. The GSI map these sandstones to be overlain by the Navan Beds (Dinantian Sandstones, Shales and Limestones) which consist of dark limestone, mudstone and sandstone. The Navan Beds are in turn overlain by the

Ballysteen Formation (Dinantian Lower Impure Limestone). This bedrock geological formation is comprised of dark muddy limestone and shale.

A major fault, known as the Ferbane Fault, is mapped along the northwestern side of the inlier (trending northeast to southwest) down throwing the succession to the northwest of the fault. This major fault is mapped below the centre of the Proposed Project site and juxtaposes the Waulsortian Limestones against the older Navan Beds and Ballysteen Formations. The Waulsortian Limestone (Dinantian Pure Unbedded Limestones) comprise of massive, unbedded lime-mudstones and underlier the northwest of the Proposed Project site. The Ferbane Fault is itself displaced by several smaller northwest to southeast trending faults.

Whilst several of these faults are mapped in close proximity to the Proposed Project infrastructure, these faults were active 100s of millions of years ago and pose no risk to the Proposed Project.

These details are provided for context, and the presence of these mapped geological structures will not affect the flood risk of the Proposed Project site.

Further details on the local geology are provided in Chapter 8 of the EIAR.

3.4 DESIGNATED SITES & HABITATS

Within the Republic of Ireland designated sites include Natural Heritage Areas (NHAs), proposed Natural Heritage Areas (pNHAs), candidate Special Areas of Conservation (cSAC), Special Areas of Conservation (SAC) and Special Protection Areas (SPAs).

The Proposed Project site is not located within any designated site. However, there are downstream hydrological connections to the designated sites as described below.

Within the Shannon Lower_SC_010 sub-catchment, the River Shannon Callows SAC/pNHA (Site Code: 000216) and the Middle Shannon Callows SPA (Site Code: 004096), are located approx. 8.5km to the northwest of the Proposed Project site. The Proposed Project site is hydrologically connected to this SAC/pNHA/SPA via the Ballynahown Stream (receives discharge from SW22D) and the Boor River. The length of the hydrological flowpath between the Proposed Project site and this SAC/pNHA/SPA is approx. 10.5km.

Within the Brosna_SC_060 sub-catchment, the River Shannon Callows SAC/pNHA (Site Code: 000216) and the Middle Shannon Callows SPA (Site Code: 004096), are located approx. 8.3km to the southwest of the Proposed Project site. The Proposed Project site is hydrologically connected to this SAC/pNHA/SPA via the tributaries of the Brosna River which receive discharge from the Proposed Project site (SW22, SW22A, SW22B, SW22C, SW19, SW19A and SW19B). The length of the hydrological flowpath between the Proposed Project site and the SAC/pNHA/SPA in this sub-catchment is approx. 22.1km.

Lough Derg, North-East Shore SAC (Site Code: 002241), the Lough Derg pNHA (Site Code: 00011) and Lough Derg SPA (Site Code: 004048) are also hydrologically connected to the Proposed Project site via the River Shannon and its associated tributaries. These designated sites are located 18.2km (straight line distance) from the TDR accommodation works at Kennedy's Cross Roads. The length of the hydrological flowpath from Lemanaghan Bog to Lough Derg is ~47km.

All other designated sites within 10km of the Proposed Project site are identified in Section 9.3.14 of the EIAR.

4. FLOOD RISK IDENTIFICATION

4.1 INTRODUCTION

The following assessment is carried out in accordance with '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*' (DoEHLG, 2009). The basic objectives of these guidelines are to:

- Avoid inappropriate development in areas at risk of flooding;
- Avoid new developments increasing flood risk elsewhere, including that which may arise from surface water runoff;
- Ensure effective management of residual risks for development permitted in floodplains;
- Avoid unnecessary restriction of national, regional or local economic and social growth;
- Improve the understanding of flood risk among relevant stakeholders; and,
- Ensure that the requirements of EU and national law in relation to the natural environment and nature conservation are complied with at all stages of flood risk management.

4.2 FLOOD RISK ASSESSMENT PROCEDURE

This section of the report details the site-specific flood risk assessment carried out for the site and surrounding area. The primary aim of the assessment is to consider all types of flood risks and the potential impact on the development. As per the Guidelines (DoEHLG, 2009), the stages of a flood risk assessment are:

- *Flood risk identification* – identify whether there are surface water flooding issues at a site;
- *Initial flood risk assessment* - confirm sources of flooding that may affect a proposed development; and,
- *Detailed flood risk assessment* – quantitative appraisal of the potential risk to a proposed development.

As per the Guidelines (DoEHLG, 2009), there are essentially two major causes of flooding:

Coastal flooding, which is caused by higher sea levels than normal, largely as a result of storm surges, resulting in the sea overflowing onto the land. Coastal flooding is influenced by the following three factors, which often work in combination:

- High tide level;

- Storm surges caused by low barometric pressure exacerbated by high winds (the highest surges can develop from hurricanes); and,

- Wave action, which is dependent on wind speed and direction, local topography and exposure.

Coastal Flooding is not applicable to the Proposed Project site.

Inland flooding which is caused by prolonged and/or intense rainfall. Inland flooding can include a number of different types:

- Overland flow occurs when the amount of rainfall exceeds the infiltration capacity of the ground to absorb it. This excess water flows overland, ponding in natural hollows

and low-lying areas or behind obstructions. This occurs as a rapid response to intense rainfall and eventually enters a piped or natural drainage system.

- River flooding occurs when the capacity of a watercourse is exceeded or the channel is blocked or restricted, and excess water spills out from the channel onto adjacent low-lying areas (the floodplain). This can occur rapidly in short steep rivers or after some time and some distance from where the rain fell in rivers with a gentler gradient.

- Flooding from artificial drainage systems results when flow entering a system, such as an urban stormwater drainage system, exceeds its discharge capacity and the system becomes blocked, and/or cannot discharge due to a high-water level in the receiving watercourse. This mostly occurs as a rapid response to intense rainfall. Together with overland flow, it is often known as pluvial flooding. Flooding arising from a lack of capacity in the urban drainage network has become an important source of flood risk, as evidenced during recent summers.

- Groundwater flooding occurs when the level of water stored in the ground rises as a result of prolonged rainfall to meet the ground surface and flows out over it, i.e. when the capacity of this underground reservoir is exceeded. Groundwater flooding tends to be very local and results from interactions of site-specific factors such as tidal variations. While water levels may rise slowly, they may be in place for extended periods. Hence, such flooding may often result in significant damage to property rather than be a potential risk to life.

- Estuarial flooding may occur due to a combination of tidal and fluvial flows, i.e., the interaction between rivers and the sea, with tidal levels being dominant in most cases. A combination of high flow in rivers and a high tide will prevent water flowing out to sea, tending to increase water levels inland, which may flood over riverbanks.

The Guidelines (DoEHLG, 2009) provide direction on flood risk and development. The Guidelines (DoEHLG, 2009) recommend a precautionary approach when considering flood risk management and the core principle of the Guidelines (DoEHLG, 2009) is to adopt a risk-based sequential approach to managing flood risk and to avoid development in areas that are at risk. The sequential approach is based on the identification of flood zones for inland and coastal flooding.

Flood zones are geographical areas within which the likelihood of flooding is in a particular range, and they are a key tool in flood risk management within the planning process as well as in flood warning and emergency planning.

There are three types or levels of flood zones defined within the guidelines:

Flood Zone A – where the probability of flooding from rivers and the sea is highest (greater than 1% (AEP)[2] or 1 in 100 for river flooding or 0.5% (AEP) or 1 in 200 for coastal flooding);

Flood Zone B – where the probability of flooding from rivers and the sea is moderate (between 0.1% (AEP) or 1 in 1000 and 1% (AEP) or 1 in 100 for river flooding and between 0.1% (AEP) or 1 in 1000 year and 0.5% (AEP) or 1 in 200 for coastal flooding); and,

Flood Zone C – where the probability of flooding from rivers and the sea is low (less than 0.1% (AEP) or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

2 AEP – Annual Exceedance Probability

Once a flood zone has been identified for a site, the guidelines set out the different types of development appropriate to each identified zone (pg. 25, Table 3.1 of the Guidelines (DoEHLG, 2009)). Exceptions to the restriction of development due to potential flood risks are provided for through the application of a Justification Test (JT), where the planning need and the sustainable management of flood risk to an acceptable level must be demonstrated by the applicant.

The Justification Test (JT) has been designed to rigorously assess the appropriateness, or otherwise, of particular developments that, for the reasons outlined above, are being considered in areas of moderate or high flood risk. The test is comprised of two processes.

- The first is the **Plan-making Justification Test** described in chapter 4 of the Guidelines (DoEHLG, 2009) and used at the plan preparation and adoption stage where it is intended to zone or otherwise designate land which is at moderate or high risk of flooding. Plan making Justification Tests are made at Plan/Policy development stage such as County Development Plans, or Local Area Plans.

- The second is the **Development Management Justification Test** described in chapter 5 of the Guidelines (DoEHLG, 2009) and used at the planning application stage where it is intended to develop land at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be inappropriate for that land. For example, application of Development Management Justification Test would be required at a site-specific level, such as for this FRA assessment, if a Justification Test is required.

4.3 FLOOD RISK IDENTIFICATION

4.3.1 Historical Mapping

There is no text on local available historical 6" or 25" OSI mapping that identifies areas that are "*prone to flooding*" within the Proposed Project site.

The local 6" basemaps indicate that lands to the south of the Proposed Project site, along the Brosna River, are "liable to flood".

4.3.2 Soils Maps – Fluvial Maps

A review of the soil types in the vicinity of the Proposed Project site was undertaken as soils can be a good indicator of past flooding in an area. Due to past flooding of rivers deposits of transported silts/clays referred to as alluvium build up within the floodplain and hence the presence of these soils is a good indicator of potentially flood-prone areas.

Based on the Teagasc/GSI soil map for the local area, there are no areas of alluvium mapped within the Proposed Project site. However, some alluvium (fluvial deposits) is recorded along many of the local streams and rivers in the lands surrounding the Proposed Project site.

Extensive alluvium deposits are mapped along the Brosna River to the south and east of the Proposed Project site. The widespread occurrence of the deposits in this area indicates the presence of a flood plain, *i.e.* a large geographic area which is prone to flooding. The closest alluvium deposits along the Brosna River are mapped ~300m from the Proposed Project site boundary. With regards to the Proposed Project infrastructure, the mapped alluvium deposits along the Brosna River are ~2.0km southeast of T15.

Elsewhere:

- Alluvium is mapped along the Ferbane stream to the southwest of the Proposed Project site and ~900m southwest of T03.

- Alluvium is mapped along The Brook stream ~900m west of the Proposed Project site.
- Extensive alluvium deposits are also mapped downstream of the Proposed Project site along the River Shannon.

4.3.3 OPW Past Flood Events Mapping

To identify those areas as being at risk of flooding, OPW's Past Flood Events Map was consulted (www.floodinfo.ie).

No recurring or historic flood incidents are recorded within the Proposed Project site. However, several flood events have been recorded in the surrounding lands.

2 no. recurring flood events (Flood ID: 2627 and 2643) are mapped along the Boor River downstream of the Proposed Project site. The flood events are located upstream of the confluence of the Boor River and the Brooks stream. The local area engineer report states that recurring flooding occurs as Ballinlassy (Flood ID: 2627) due to overbank flooding of the River Boor. Low lying lands are also noted to flood after heavy rain each year at Glebe (Flood ID: 2643). Further downstream several recurring flood events are also recorded along the Shannon River.

A recurring flood event is recorded along the R346 to the south of the Proposed Wind Farm (Flood ID: 2906) where the Ferbane area engineer notes that "*low lying flat land floods after heavy rain each year and the road is liable for flood*". This flood event is approximately 500m to the south of the Proposed Project site. A second recurring flood event (Flood ID: 2907) is also mapped ~1km west of the Proposed Project site at Derrica Beg. Here low-lying land and roads are noted to flood annually following heavy rain.

Several historic flood events have also been recorded along the Brosna River to the south of the Proposed Project site. Meanwhile, a recurring flood event (Flood ID: 13233) is recorded ~800m south of the Proposed Project site in the townland of Pollagh. Here the Brosna River overflows its banks after heavy rainfall and is liable to flood the local road.

Further downstream, there are several historic and recurring flood events mapped along the length of the River Shannon.

The OPW map the Proposed Project site as bogland, with lands to the south and east of the site along the Brosna River mapped as Benefitting land. Benefitting land is land which was drained as part of an Arterial Drainage Scheme. The Brosna (Westmeath, Offaly and Laois) was one of the first drainage schemes, which commenced in 1947. The OPW also map the presence of Benefitting land to the west of the Proposed Project site along the Blackwater River and to the north along the Brooks stream and the Boor River.

No recurring or historic flood events are mapped in the immediate vicinity of the TDR works area at Kennedy's Cross. The closest mapped flood events are located at Birr to the south.

The OPW Past Flood Events Map is presented as **Figure E** below.

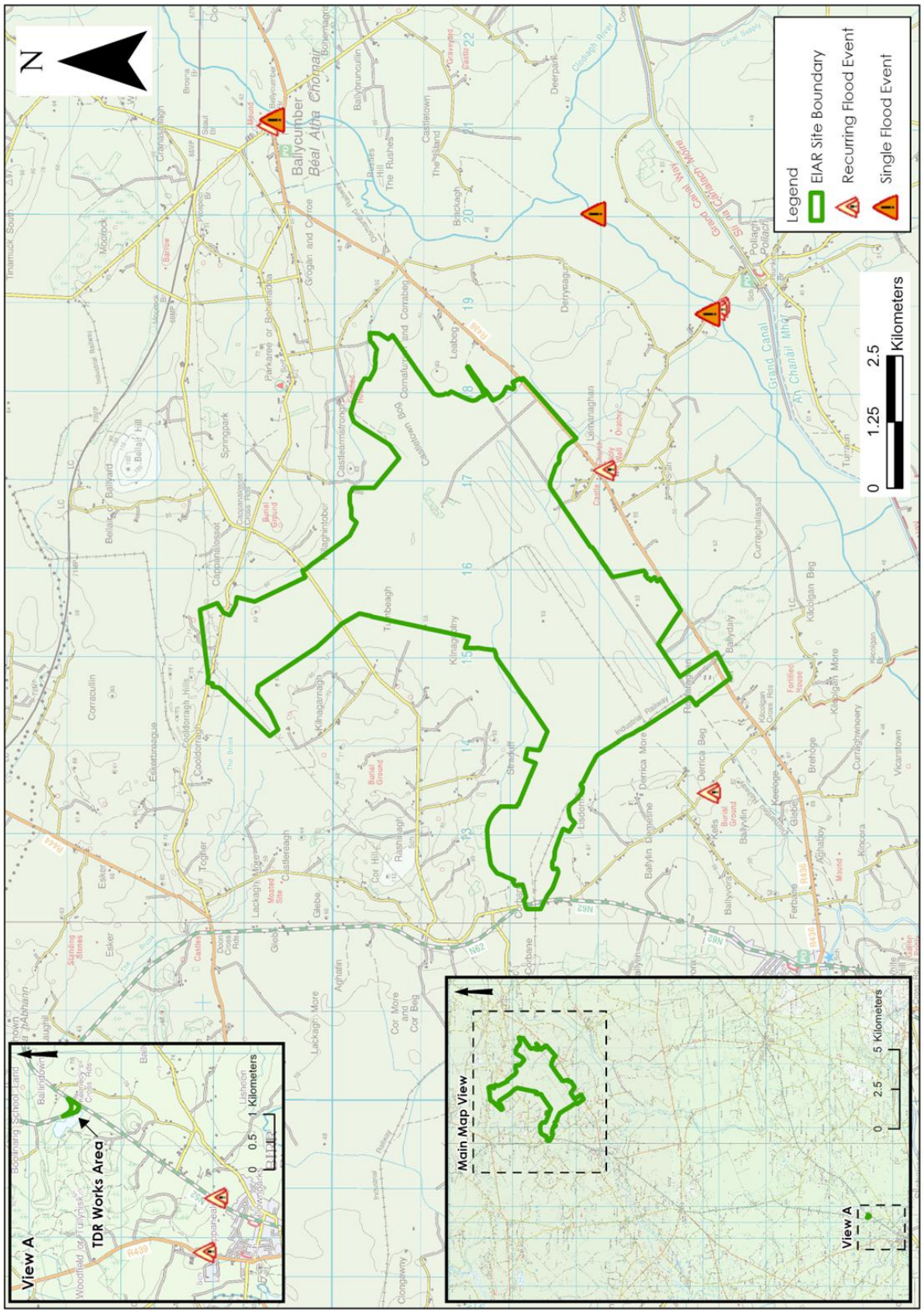

Figure E: OPW Past Flood Events Map

4.3.4 GSI Historical Surface Water Flood Mapping

The GSI Winter (2015/2016) Surface Water Flooding map shows areas of fluvial and pluvial flood extents during the Winter 2015/2016 flood event, which was the largest recorded flood event in many areas. This surface water flood map is available to view at www.floodinfo.ie.

This historical surface water flood map records some areas of surface water flooding within the Proposed Project site. These mapped historic flood zones are located along the EPA mapped Lemanaghan Stream and extend to the southwest and northeast of the mapped watercourse along several of the lower lying peat fields. Several elements of the Proposed Project are located in the vicinity of this historic flood zone.

Information from BnM operatives familiar with Lemanaghan Bog confirmed that during historical industrial peat extraction, which ceased in June 2020, surface water flooding occurred on occasion in the former industrial peat production areas within Lemanaghan Bog where blockages to the existing drainage network were in place over winter months.

Extensive surface water flooding was also recorded along the Brosna River to the south of the Proposed Project site. The mapped extent of the flooding does not encroach upon the Proposed Project site.

The GSI Winter (2015/2016) Surface Water Flood Mapping is shown as **Figure F**. Some elements of the Proposed Wind Farm, including T12 and T6 are mapped in these historic surface water flood zones.

There are no historic surface water flood zones mapped in the area of the TDR works at Kennedy's Cross.

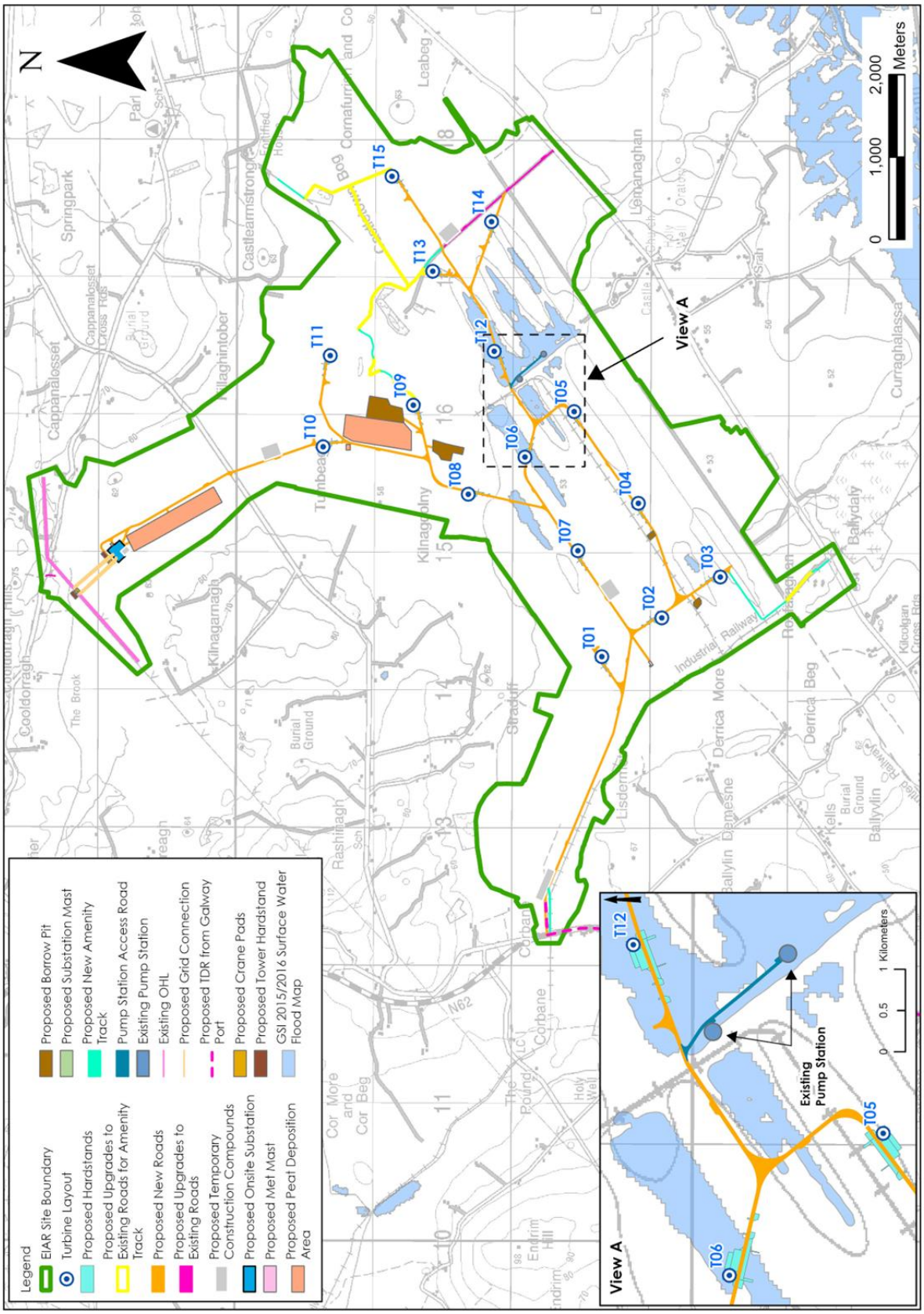

Figure F: GSI Historical Surface Water Flood Map

4.3.5 CFRAM Fluvial Flood Mapping

Catchment Flood Risk Assessment and Management (CFRAM)[3] OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the previous PFRA[4] maps.

CFRAM mapping has been completed along the Brosna River to the south of the Proposed Project site. The modelled fluvial flood zones in this area extend a significant distance from the mapped river channel indicating the presence of a floodplain. However, the flooding does not encroach upon the Proposed Project site with the exception of an existing BnM railway line which traverses the site. With regards to the Proposed Project infrastructure, the low probability fluvial flood zone associated with the 1 in 1,000-year flood event is situated ~1.6km from the nearest proposed turbine location (T03).

Further downstream and to the southwest of the Proposed Project site near Ferbane the flood zones become more localised to the immediate vicinity of the river channel. CFRAM mapping for the local area is shown as **Figure G**.

The modelled CFRAM flood extents show flood levels along the Lemanaghan Stream of 44.86 to 44.99m OD for the 10-year and 100-year flood events respectively (refer to **Table C** below).

Note that these modelled flood levels are below the surveyed outfall pipe elevations at all settlement ponds with the exception of SW22 (refer to **Table A**, and note that no data is available for SW19).

Further downstream extensive flood zones are mapped at the confluence of the Brosna and Shannon River and along the River Shannon as far as Lough Derg.

Note that there are no mapped CFRAM flood zones in the area of the TDR works at Kennedy's Cross.

Table C: CFRAM Modelled Fluvial Water Levels (www.floodmaps.ie)

Node Label	Location Description	10% AEP WL (mOD)	1% AEP WL (mOD)	0.1% AEP WL (mOD)
01STD00730	Lemanaghan Stream, ~600m southwest of the Proposed Project site	44.81	44.86	44.99
01STD00000	Lemanaghan Stream upstream of its confluence with the Brosna	44.35	44.78	45.01
03BSN12281	Brosna River	44.3	44.76	44.98

4.3.6 OPW National Indicative Fluvial Flood Mapping

The National Indicative Fluvial Flood Mapping (NIFM) (www.floodinfo.ie) shows probabilistic fluvial flood zones for catchments greater than 5km^2 for which flood maps were not produced under the CFRAM Programme.

The Present-Day Scenario has been generated using methodologies based on historic flood data and does not consider the potential changes due to climate change. The potential effects of climate change on flooding have been separately modelled (see **Section 4.3.9** below.)

3 CFRAM is Catchment Flood Risk Assessment and Management. The national CFRAM programme commenced in Ireland in 2011 and is managed by the OPW. The CFRAM Programme is central to the medium to long-term strategy for the reduction and management of flood risk in Ireland.
4 Preliminary Flood Risk Assessment mapping.

For the present-day scenario, the low (1,000-year flood event) and medium (100-year flood event) probability fluvial flood zones are recorded in the main bog area along the EPA mapped Lemanaghan Stream. The flood zones extend some distance away from the mapped watercourse. This is likely due to the low-lying nature of some of the peat fields (historic peat extraction has lowered the topography of the local area). With respect to the Proposed Project infrastructure, T12 and associated proposed new access roads are mapped within the low probability fluvial flood zone. Please note that the mapped NIFM flood zones along the Lemanaghan Stream are similar to the historic flood zones recorded by the GSI (refer to **Section 4.3.4**).

Site walkover surveys have revealed that the EPA mapped Lemanaghan Stream has been modified within the Proposed Project site and now forms part of the bog drainage infrastructure. A large arterial drain was noted to flow along the course of the EPA mapped Lemanaghan Stream. This drain receives water from field drains which drain the adjacent peat fields. 2 no. existing pumping stations, operated by BnM, were also noted along this large drain, and the operation of these pumping stations would have removed water from the lower lying parts of the bog and raised, and discharged, that water to the outfalls along the Lemanaghan Stream. In general, pumping stations and flood protection embankments are not used in NIFM/CFRAM flood modelling, and the risk of flooding from those modelling outputs (NIFM/CFRAM) are defined (by creating flood zones/maps) in the absence of flood defences.

No additional flood zones are mapped to encroach upon the Proposed Project site. However, NIFM flood zones are located on the Boor River, the Brooks Stream and the Blackwater River downstream of the Proposed Project site.

Note that there are no NIFM fluvial flood zones mapped in the area of the TDR works at Kennedy's Cross.

The NIFM flood zones in the local area are shown on **Figure G** below.

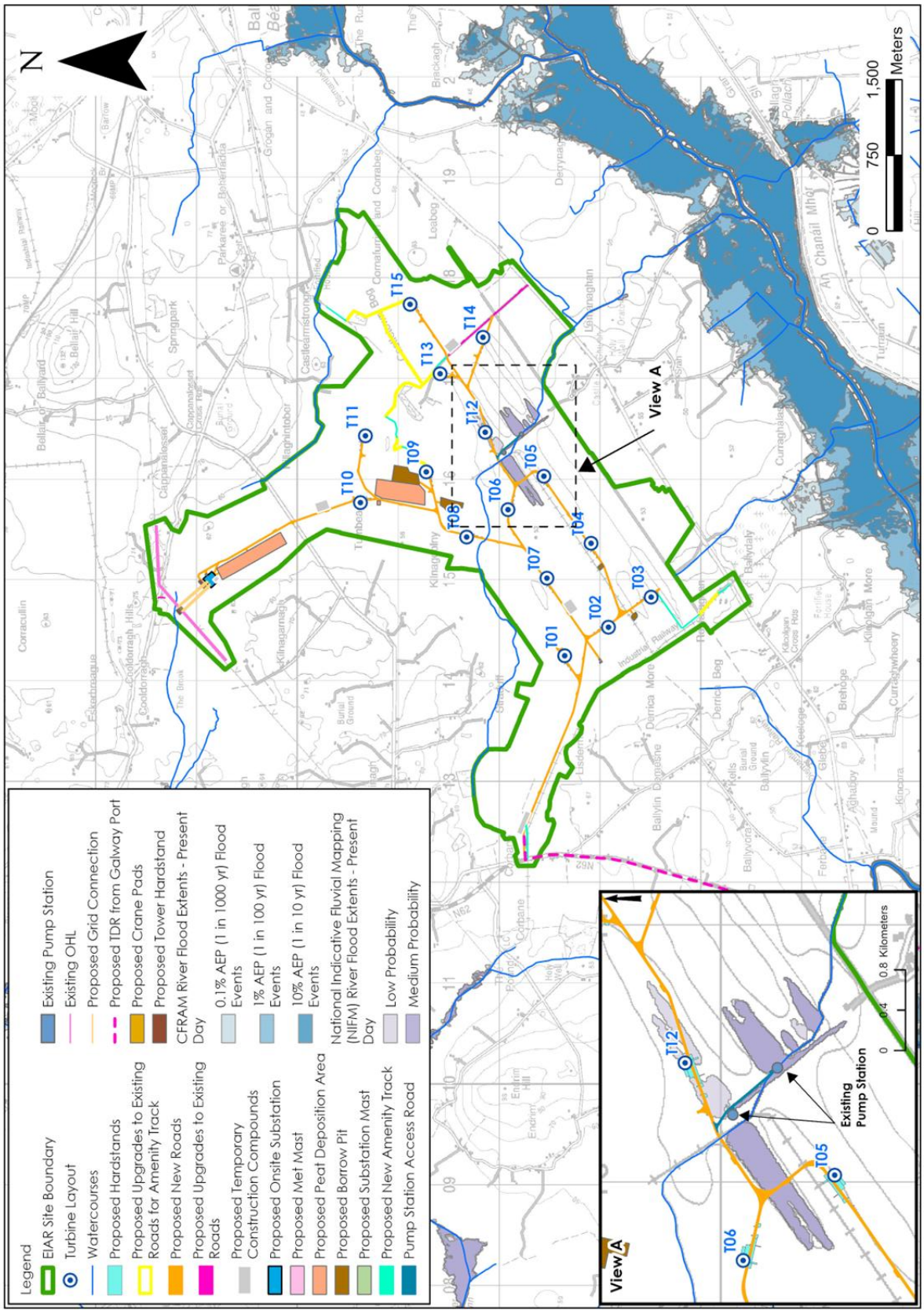

Figure G: CFRAM and National Indicative Fluvial Flood Mapping

4.3.7 Groundwater Flooding

The GSI Historical Groundwater flood map and the modelled groundwater flood extents map (www.floodinfo.ie) do not show the occurrence of any groundwater flooding within the Proposed Project site.

The closest historic groundwater flood zone is mapped approximately 950m to the west of the Proposed Project site in the townland Lisdermot.

There are no groundwater flood zones mapped in the area of the TDR works at Kennedy's Cross.

4.3.8 Coastal Flooding

The Proposed Project site is located in the Irish midlands and a significant distance (~100km) from the coast. There is no risk of coastal flooding.

4.3.9 Climate Change

It is likely that climate change will have significant impacts on flooding and flood risk in Ireland due to rising sea levels, increased winter rainfall and more intense rainfall.

The CFRAM Programme has modelled flooding associated with potential 2 no. future climate change scenarios. The Mid-Range and High-End Future Scenario flood extents were generated using an increase in rainfall of 20% and 30% respectively. The extent of the CFRAM flood zones along the Brosna River increase slightly for each future scenario. However, the low probability flood zone associated with the High-End Future Scenario does not encroach upon the Proposed Project site.

Similarly, NIFM mapping has been modelled for the 2 no. potential future climate change scenarios. Both of these modelled flood extents show similar flood zones to the Present-Day Scenario discussed above in **Section 4.3.6**.

Therefore, flood zones at the Proposed Project site are unlikely to be significantly impacted by future climate change.

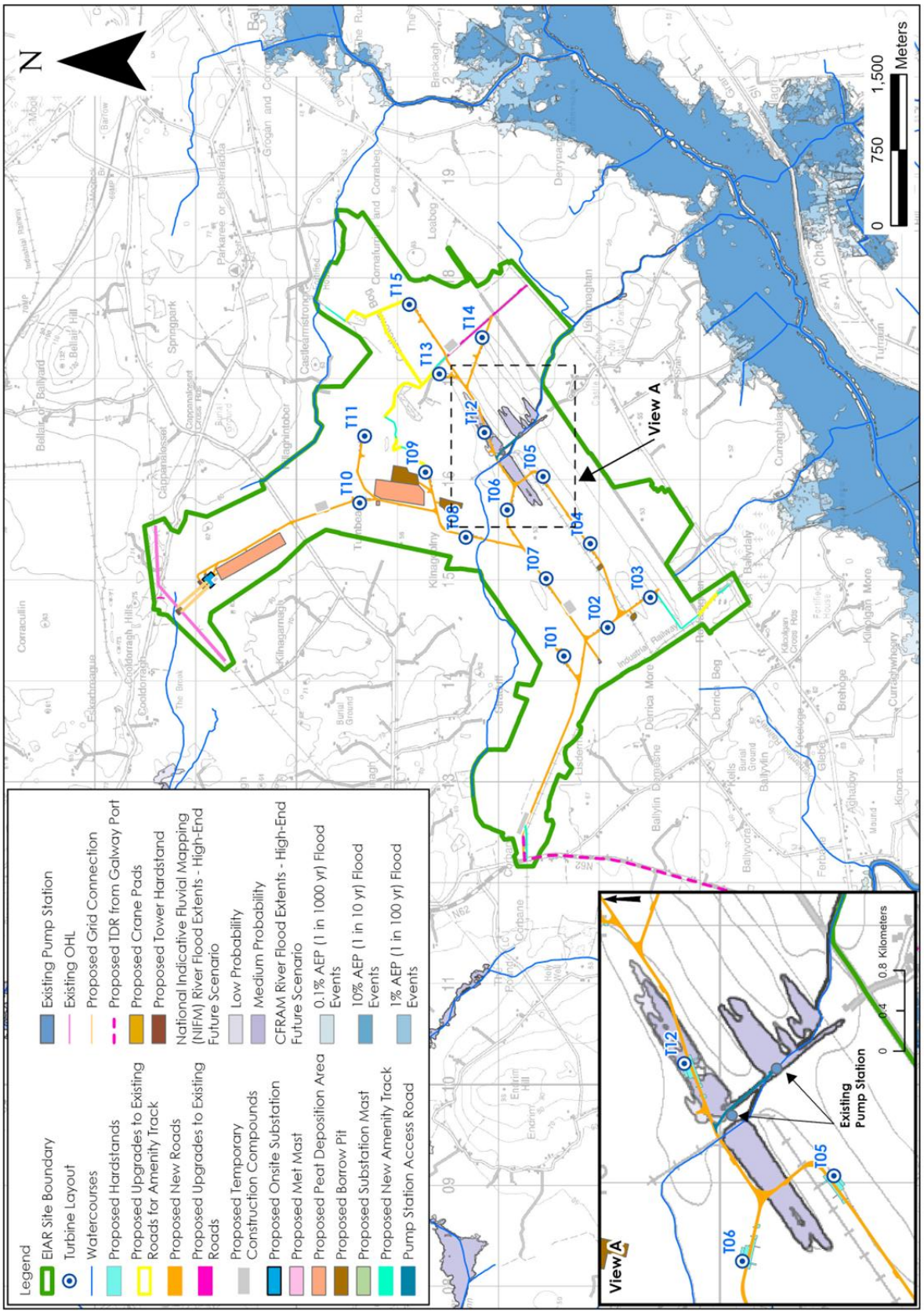

Figure H: High-End Future Scenario Fluvial Flood Zones

4.3.10 Summary – Flood Risk Identification

Based on the information gained through the flood identification process, it would appear parts of the Proposed Project site are affected by fluvial flooding. While the majority of the Proposed Project site is mapped in Flood Zone C, the GSI historical flood mapping and the National Indicative Fluvial Flood mapping shows that some areas of the site are mapped in Fluvial Flood Zones A and B. Flooding in these areas is likely due to the flooding along the Lemanaghan stream. Note that walkover surveys have revealed that this watercourse has been modified during the historical peat extraction activities and now forms part of the existing bog drainage infrastructure. – additional information is provided in Section 4.4.1).

Due to the low permeability of the soils and subsoils present at the Proposed Project site, pluvial flooding and surface water ponding may also be an issue.

An extensive flood plain occurs to the south of the Proposed Project site along the Brosna River. However, the flood zones A and B do not encroach upon the Proposed Project site.

4.4 DETAILED FLOOD RISK ASSESSMENT

4.4.1 Site Surveys

Hydrological walkover surveys and observations on the site drainage patterns were undertaken by HES on 8th July 2021, 1st and 7th August 2024 and 17th April 2025.

During the site walkover land use across the Lemanaghan Bog was noted as comprising of cutover bog where industrial peat extraction has previously occurred. Note that peat extraction formally ceased at Lemanaghan Bog in June 2020. The bog was noted to be drained by regularly spaced field drains which drain towards larger arterial drains. Meanwhile certain areas of the site have become overgrown, with industrial peat production ceasing in these areas some time ago allowing vegetation to recover and recolonise the bare peat fields. At the boundaries of the bogs surface water draining from the site is routed via large settlement ponds prior to discharge to off-site drainage channels which flow into the local rivers and streams.

During the site walkover, the Lemanaghan Stream was observed on site and has been integrated into the existing bog drainage regime. 2 no. existing pumps were also observed along the Lemanaghan Stream during the site walkovers. The EPA mapped Lemanaghan Stream resembled a large arterial drain and has been modified from its natural state. A large arterial drain was noted to flow along the course of the EPA mapped Lemanaghan Stream. This drain receives water from field drains which drain the adjacent peat fields. 2 no. pumping stations, operated by BnM, were also noted along this large drain, and the operation of these pumping stations would have removed water from the lower lying parts of the bog and raised, and discharged, that water to the outfalls along the Lemanaghan Stream. In general, pumping stations and flood protection embankments are not used in NIFM/CFRAM flood modelling, and the risk of flooding from those modelling outputs (NIFM/CFRAM) are defined (by creating flood zones/maps) in the absence of flood defences.

Several low-lying areas within the bog were observed to hold surface water following heavy rainfall, but ponding only occurs to very shallow depths, (<0.2m) and only in certain areas does ponding persist in drier periods. Similarly, flooding likely occurs in the lower peat fields adjacent the Lemanaghan Stream when the pumps are turned off. Due to the low lying and relatively flat nature of the site, the flooding is shallow.

Information from BnM operatives familiar with Lemanaghan Bog confirmed that outfalls will become submerged when the water levels of the watercourses into which they are discharging are high. The receiving watercourses would then backwater the outfalls reducing the head for discharge and causing water to be stored on the bog until such time as the rivers have receded.

4.4.2 Hydrological Flood Conceptual Model

Potential flooding in the vicinity of the Proposed Project site can be described using the Source – Pathway – Receptor Model ("S-P-R").

The primary potential pathways would be overbank flooding of the Lemanaghan Stream in combination with pluvial flooding during significant rainfall events. The potential receptors in the area are infrastructure and land as outlined below.

4.4.3 Summary – Initial Flood Risk Assessment

Based on the information gained through the flood identification process and Initial Flood Risk Assessment process it is apparent that flooding is likely to be problematic at the Proposed Project site. The potential sources of flood risk for the Proposed Project site are outlined and assessed in **Table D.**

Table D: S-P-R Assessment of Flood Sources for the Proposed Project site

Source	Pathway	Receptor	Comment
Tidal	Not applicable	Land and infrastructure.	The Proposed Project site is 100km from the coast and there is no risk of coastal flooding.
Fluvial	Overbank flooding of the Lemanaghan stream	Land and infrastructure.	According to the GSI Historical Surface Water Flood Mapping, areas of the Proposed Project site, adjacent to the Lemanaghan Stream flooded during the winter of 2015/2016. NIFM flood zones are also mapped along the Lemanaghan Stream. The majority of the Proposed Project infrastructure and the majority of the Proposed Project site is located in Flood Zone C (Low Risk). However, 1 no. turbine and a section of proposed new road are located in mapped fluvial flood zones (i.e. Flood Zones A and B).
Pluvial	Ponding of rainwater on site	Land and infrastructure.	The Proposed Project site is generally low lying and flat in places and given the nature of the soils/subsoils (cutover peat), localised shallow pluvial flood is very likely after heavy or prolonged rainfall.
Surface water	Surface ponding/ Overflow	Land and infrastructure	Same as above (pluvial).
Groundwater	Rising groundwater levels	Land and infrastructure.	Based on the local hydrogeological regime and GSI groundwater flood mapping, there is no apparent risk of groundwater flooding at the Proposed Project site.

4.4.4 Requirement for a Justification Test

The matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test[5] is shown in
Table E below.

It may be considered that the Proposed Project can be categorised as "Highly Vulnerable Development". As stated above, some key development infrastructures including 1 no. turbine and a section of proposed new road are located in mapped Fluvial Flood Zones.
Consequently, the Proposed Project is potentially at risk of flooding and would require further justification from a planning perspective (refer to
Table E below).

[5] *A 'Justification Test' is an assessment process designed to rigorously assess the appropriateness, or otherwise, of particular developments that are being considered in areas of moderate or high flood risk, (DoEHLG, 2009).*

Site specific modelling is outlined in **Section 4.4.5** in respect of the proposed onsite 220kV substation as it needs to be demonstrated that it is located in Flood Zone C. And further analysis of the T12 area is also completed in Section 0 for infrastructure areas that are proposed within mapped NIFM flood Zones A and B.

Table E: Matrix of Vulnerability versus Flood Zone

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	**Justification test**	**Justification test**	**Appropriate**
Less vulnerable development	Justification test	Appropriate	Appropriate
Water Compatible development	Appropriate	Appropriate	Appropriate

Note: Taken from Table 3.2 (DoEHLG, 2009)
***Bold:** Applies to this Proposed Project site*

4.4.5 Detailed Flood Risk Assessment For The Proposed Onsite 220kV Substation

Due to the sensitivity of the proposed onsite 220kV substation, we have completed a detailed assessment to determine a proposed floor level (or formation level) that is above the predicted 1-1000yr pluvial flood level.

A detailed drainage map of the area of the proposed onsite 220kV substation is provided as **Figure I**.

The existing ground levels at the proposed onsite 220kV substation location varies between ~56 to ~57 mOD. As shown on **Figure I**, the proposed onsite 220kV substation location is within catchment LM18, and this catchment drains to the north and outfalls to the Ballynahown Stream (also known as the Brooks Stream). Catchment area LM16 also drains to the same stream. The mapped invert of the outfall drain to the north of the proposed onsite 220kV substation location is 53.42 mOD, with a recorded SWL (surface water level) of ~54mOD.

No part of the proposed onsite 220kV substation location is mapped in any flood zone from the available flood mapping (National Indicative Flood Mapping, CFRAM, GSI Groundwater flood mapping).

In order to determine if the proposed onsite 220kV substation location is above the 1,000-year flood level (*i.e.* Low Probability) we modelled flood levels by applying 1,000-yr rainfall depths (including a climate change factor of +20%) to the surface water catchment within the area of the proposed onsite 220kV substation. Based on available topography and the existing drainage regime in this area of the bog, the area with catchment LM18 is the only catchment area that can contribute to flooding of the proposed onsite 220kV substation location. However, in order to be conservative we have also included catchment LM16 in our analyses, as this catchment also outfalls to the same stream as the proposed onsite 220kV substation location (LM18 catchment). The total catchment area feeding from the north of Lemanaghan Bog to the Ballynahown stream is 0.2005km^2.

For a catchment area of 0.2005km^2, the mean annual flood (Using Institute of Hydrology Report 124) discharge from Lemanaghan north (LM16 and LM18 catchments) is calculated at 0.101m^3/sec. The estimated 100-yr and 1000-yr flood flows (using growth factors and applying a climate change factor of 1.2) from the northern catchments is (Q100) 0.324m^3/sec and (Q1000) 0.44m^3/sec respectively.

Extreme rainfall depths for the Proposed Project site were determined using the Met Éireann 20 km by 20 km model of rainfall depth-duration-frequency model (www.met.ie). The rainfall totals at different durations and return periods are presented below in **Table B**.

A lidar survey at a 2m grid interval of the entire Lemanaghan Bog (north) unit was used to determine the flood volume available in the northern catchments (LM16 and LM18) of the bog (0.2005km^2 catchment) at various water elevations. This information is presented in **Table** F.

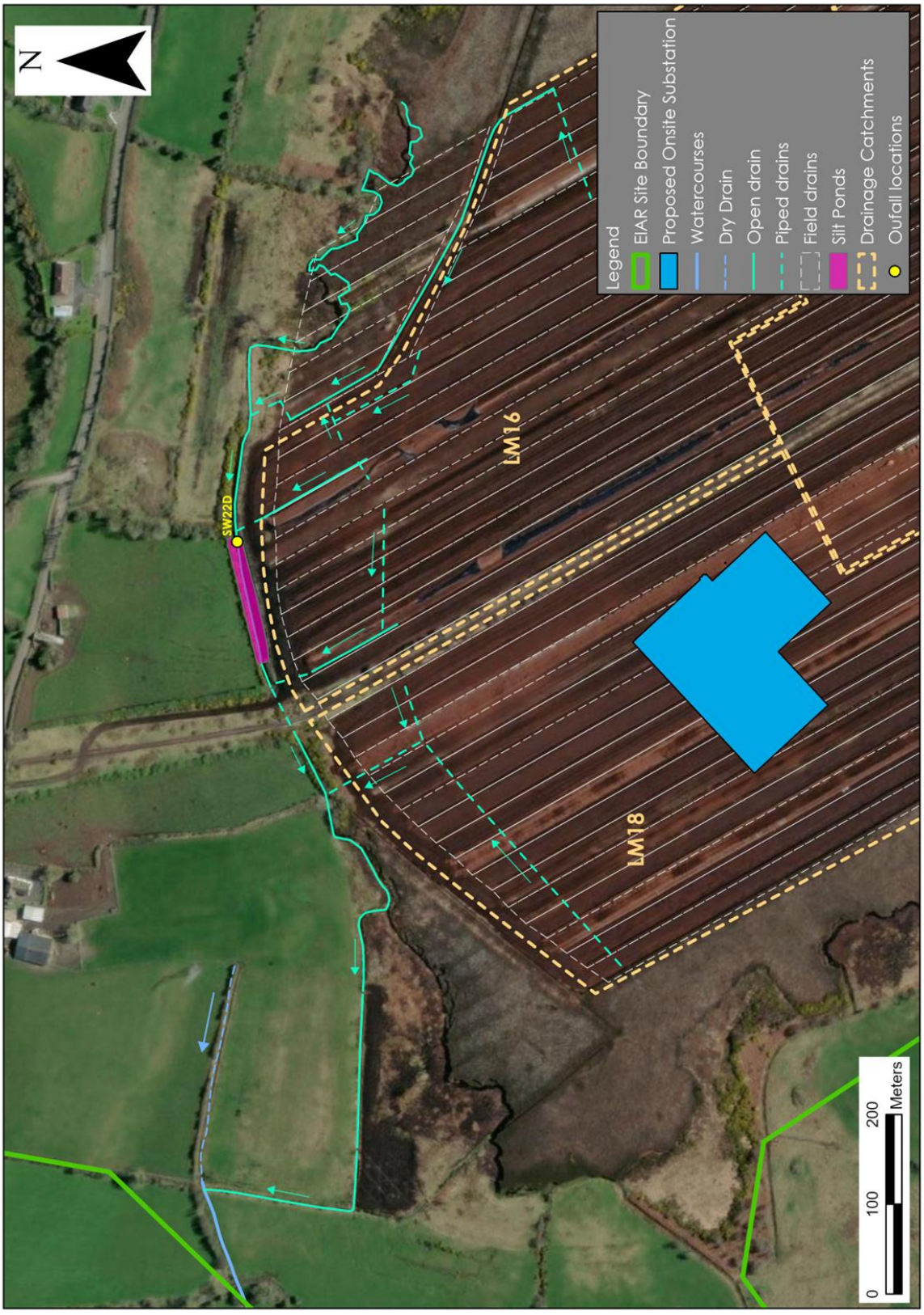

Figure I: Existing Drainage at the Proposed Onsite 220kV Substation Area

Table F shows that significant storage is available within the area of the proposed onsite 220kV substation due to the expanse of open bog area (0.2005km^2), the flat nature of the ground

(small increases in water level requires large volumes of water), and the shallow field drains that were created by the previous peat extraction works.

As a preliminary assessment, a conservative volumetric (catchment area x rainfall depth for each return period and storm duration) and flood storage calculation with Q_{100} and Q_{1000} discharges from the catchment was undertaken for various rainfall durations. Under this scenario, with no discharge on day 1, the peak storage occurs for a 1-day duration rainfall events in both return periods (T_{100} and T_{1000}), with the storage required for longer duration events being exceeded by the discharge from the catchment over time (i.e. on day 2 and after beyond the peak of the flood event). A summary of these volumetric calculations is provided in **Table G**.

Using the stage-volume relationship presented in **Table** F, it is possible to calculate the flood elevation for each return period. These are shown in **Table H.**

Table F: Area of Lemanaghan Bog Surrounding the Proposed Onsite 220kV Substation – Storage-Volume Relationship

Stage mOD (Malin)	Volume (m^3)
54.5	0
54.75	0.02
55.0	5.08
55.25	50.41
55.5	254
55.75	1,258
56.0	4,954
56.25	15,153
56.5	34,778
56.75	64,648
57.0	103,158

Table G: Area of Lemanaghan Bog Surrounding the Proposed Onsite 220kV Substation - Storage Volumes in T_{100} and T_{1000} rainfall events

Rainfall Event Duration	T_{100} Residual Storage Volume (m^3)	T_{1000} Residual Storage Volume (m^3)
24hrs (1 day)	7,988	30,354
2 days	Discharge > Storage	Discharge > Storage
3 days	Discharge > Storage	Discharge > Storage
4 days	Discharge > Storage	Discharge > Storage
25 days	Discharge > Storage	Discharge > Storage

Table H: Area of Lemanaghan Bog Surrounding the Proposed Onsite 220kV Substation – Estimated Flood Levels for T_{100} and T_{1000} rainfall events

Rainfall Event	Estimated Peak Flood Level (mOD Malin)
T_{100}	~56.1
T_{1000}	~56.45

Summary – Detailed Flood Risk Assessment for Proposed Onsite 220kV Substation

As outlined above a very conservative volumetric analysis has determined the peak flood levels at the proposed onsite 220kV substation site for 100-yr and 1000-yr rainfall events.

The overriding factor in the analysis is the large area of available bog for pluvial water storage within LM16 and LM18, and also the positive drainage outfall available to the north of the bog. In addition to the above analysis, a freeboard of 0.3m is added to the determined flood levels to define the required floor/formation level for the proposed onsite 220kV substation. Applying this to the T_{1000} flood level gives a required substation floor/formation level of **>56.75mOD**. At this elevation the proposed onsite 220kV substation is in flood zone C, and the risk of flooding at the proposed onsite 220kV is negligible.

Finally, as noted above, the mapped invert of the outfall drain to the north of the proposed onsite 220kV substation location is 53.42 mOD, with a recorded SWL (surface water level) of ~54mOD, so as long as this outfall drain is maintained, there will always be positive drainage in this area and the risk of flooding at the proposed onsite 220kV substation is negligible.

4.4.6 Detailed Flood Risk Assessment for Proposed Infrastructure within Mapped Flood Zones

As described in Section 4.3.4 and Section 4.3.6 areas of the Proposed Project site are mapped in Fluvial Flood Zones A and B. In terms of the Proposed Project infrastructure, 1 no. turbine (T12) and its associated hardstand and access roads are located in these mapped flood zones.

This area of the bog is modelled to flood as its elevations have been lowered due to the historical industrial peat extraction activities. The centre of the bog is now at a lower elevation than its outfalls and 2 no. existing pumps are required to discharge the water from the bog drainage network to the downstream natural watercourse (*i.e.* the Lemanaghan Stream).

The proposed infrastructure (T12, T12 hardstand, and section of new internal road between T12 and T05) in this area will be above existing ground level (top of formation level is 48.1mOD for T05 and 48.5mOD for T12), and will therefore displace pluvial flood water and as a result will increase the water depth locally within the bog during higher rainfall events. The total development footprint in these areas (T12, T12 hardstand, and section of new internal road between T12 and T05) is ~9,300m^2, and local increases in flood levels within the local bog areas arising from this displacement equates to between 5-15cm for extreme rainfall events. There is no increase to downstream flood risk, as this water will be retained within the Proposed Project site, and can only be removed via pumping (i.e. there is no gravity outfall).

5. FLOOD IMPACT PREVENTION AND DRAINAGE MANAGEMENT

5.1 PROPOSED SITE DRAINAGE

The Proposed Project drainage will not significantly alter the existing drainage regime at the site. Moreover, the proposed drainage system will be fully integrated into the existing bog drainage systems.

Existing field drains and main drains will be routed under/around proposed wind farm access tracks using culverts as required.

Runoff from access tracks, turbine bases, and developed areas (construction compounds, sub-station, met masts etc) will be collected and treated in local (proposed) silt traps and then discharged to existing local peat field drains. From there water will flow towards the site boundaries in field drains and main drains) and be treated further in the existing main settlement ponds prior to discharge from the Proposed Project site . The outfall locations from Lemanaghan Bog to nearby surface watercourses are shown on Figure D above.

5.2 FLOOD RISK MANAGEMENT ASSOCIATED WITH BIODIVERSITY ENHANCEMENT AND MANAGEMENT PLAN

The Proposed Project includes a Biodiversity Management and Enhancement Plan (BEMP) which is included as Appendix 6-5 of the EIAR. The BEMP has been designed to enhance the existing habitats at the Site and all works detailed in the BEMP.

Several elements of the BEMP have no potential to change the hydrological/hydrogeological conditions at the Proposed Project site and therefore have no potential to alter the flood risk at or upstream/downstream of the Proposed Project site due to the minor nature of the proposed works. These works include the planting of natural hedgerows, native woodland and enhancement for marsh fritillary.

Other elements of the BEMP include the control of flooding in a 10ha area to an approximate depth of 1.5m. This will be achieved by creating an encircling embankment to contain the water. The controlled flooding will be such that water will be present during the winter months when whooper swan are present (October to March). The element of the proposed BEMP will provide greater attenuation of surface water at the Proposed Project site during winter when surface water runoff rates are greatest. This will reduce the downstream flood risk.

Furthermore, this element of the proposed BMEP is located in the northwest of the Proposed Project Site and has no potential to increase flood risk at any of the Proposed Wind Farm infrastructure locations. The flooding will be controlled by means of a sluice gate and waters will be enclosed by berms.

An additional 10ha in the west of the Proposed Project site is proposed for enhancement to create suitable breeding habitats for Lapwing. The proposed enhancement measures include drain reprofiling and infilling. These measures will improve attenuation of surface water within this area of the bog and will reduce the downstream flood risk.

Therefore, the cumulative effect of the Proposed Wind Farm and the proposed BEMP is that there will be no increase in the flood risk at the Proposed Project site (outside of the designated 10ha which is proposed to flood in winter), and there will be a slightly reduced downstream flood risk as more water will be attenuated retained within the bog as a result of the proposed BEMP measures.

5.3 FLOOD RISK IMPLICATIONS ASSOCIATED WITH PROPOSED DECOMMISSIONING AND REHABILITATION PLANS

In June 2020 industrial peat extraction ceased at Lemanaghan Bog, BnM's Cutaway Bog Decommissioning and Rehabilitation Plans will be implemented in in order to fulfil the requirements of Condition 10.2 of the IPC licence No. P0500-01.

BnM have devised rehabilitation plans to stabilise and rehabilitate the peat bog of Lemanaghan Bog, in which the majority of the Proposed Project site is located. The plans use bespoke interventions designed to first stabilise the environment, and secondly to rehabilitate the bogs as much as possible by placing the existing peatland environments on a path towards naturally functioning peatlands. Rehabilitation allows a site to naturally colonise with vegetation to stabilise the bare peat production fields and minimise potential downstream water pollution and surface water runoff.

BnM have produced a Draft Cutaway Bog and Decommissioning Rehabilitation Plan (Draft Rehabilitation Plan) for Lemanaghan Bog, provided as Appendix 2-4 to the EIAR, and it is the intention of BnM to rehabilitate the bog in a phased approach under IPC Licence. The proposed rehabilitation measures include regular drain blocking, outfall modification and water level management through the use of overflow pipes. The proposed measures will result in greater attenuation of surface water at Lemanaghan Bog which will result in improvements in flow and water quality. The proposed rehabilitation measures will reduce downstream flood risk by enhancing the capacity of Lemanaghan Bog to attenuate surface water runoff.

Furthermore, the Proposed Project will be constructed with its own drainage system which will provide additional surface water attenuation within Lemanaghan Bog.

The cumulative effect of the Proposed Project and the Draft Rehabilitation Plans is that the bog will store more water following rainfall and as a result there will be a reduced risk of fluvial flooding downstream of the Proposed Project site.

6. JUSTIFICATION TEST

6.1 JUSTIFICATION TEST

Box 5.1 (**Table I** below) of "The Planning System and Flood Risk Management Guidelines" (PSFRM Guidelines) outlines the criteria required to complete the "Justification Test".

Table I: Format of Justification Test for Development Management

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 of the Guidelines, 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.

Note: *this table has been adapted from Box 5.1 of "The Planning System and Flood Risk Management Guidelines", (2009).*

Referring to Point 1 and Points 2 (i) to (iv) inclusive in Figure 20 [of PSFRMG guideline document]:

1. The Proposed Project is currently in the planning process and has been deemed suitable for development by the Applicant. The Applicant is aware of the fluvial and pluvial flood risks associated with the Proposed Project site and they have included design responses to ensure flood resilience for sensitive elements of the Proposed Project. The proposed onsite 220kV substation is located in Flood Zone C and is located above the predicted fluvial and pluvial flood elevations.

2. The proposal for 15 no. turbine wind farm and associated access tracks, construction compounds, cable trench route, Proposed Grid Connection, amenity tracks, amenity carpark and other ancillary works have been the subject of Stage III SSFRA (this report) and this assessment has shown that:

    i. The Proposed Project has been assessed to have no significant potential to impact on flood risk upstream or downstream of the Proposed Project site.

    ii. The Proposed Project will not impede or accelerate the flow of surface water during extreme flood events. Drainage designs for the Proposed Project follow SuDS principles and will restrict discharge rates to greenfield flows. In addition, modelling has demonstrated that the proposed onsite 220kV substation is above the 1,000-yr flood level (proposed floor level >56.75mOD). There will be

no increase in flood risk on lands upstream or downstream Proposed Project site.

With regards to the Proposed Project site, it will for the large part remain flood free, but on very rare occasions there is a risk of shallow inundation from pluvial flooding. The pluvial flooding occurs on the lower peat fields, particularly during times when the pumps along the large arterial drain are turned off. However, all turbine bases will be constructed above the modelled Extreme pluvial and fluvial flood levels.

Surface water discharges from the site are attenuated and will be slowed down below greenfield runoff rates. Surface water will be held on-site, behind access tracks, in shallow wet areas, in low lying areas, in silt traps, in settlement ponds, and upstream of pumping stations.

Given the large area of the Proposed Project site (~1,258ha), Lemanaghan Bog has an enormous capacity to store water following rainfall events, even if storage is only a couple of centimetres in depth, the volume of stored water will be very large.

Overall, during the wind farm operation phase of the Proposed Project, water is more likely to be held on-site, and this will have a positive impact on downstream flooding events. The proposed BMEP measures, particularly the creation of the seasonal flooded area for whooper swan and the enhancement for lapwing (drain reprofiling and infilling), will provide greater attenuation of surface waters at the site and will have a positive effect on downstream flood risk during winter months.

No part of the Proposed Project infrastructure will flood, and all access roads and turbine bases will be designed to be above known pluvial flood levels.

The proposed onsite 220kV substation will be raised to be above the 1 in 1,000-year flood level as outlined above and will include a 300mm freeboard (i.e. >56.75mOD).

iii. The proposed infrastructure (T12, T12 hardstand, and section of proposed new road between T12 and T05) will displace pluvial flood water and as a result will increase the water depth locally within the bog during higher rainfall events. The total development footprint in these areas is ~9,300m^2, and local increases in flood levels within the local bog areas arising from this displacement equates to between 5-15cm for extreme rainfall events. There is no increase to downstream flood risk, as this water will be retained within the Proposed Project site, and can only be removed via pumping (i.e. there is no gravity outfall).

For the remainder of the Proposed Project site, the SSFRA has shown that there will be no residual risks to the Proposed Project or local area.

All proposed infrastructure will be constructed above known flood levels, and there will be no potential impediment for access of Emergency Service vehicles; and,

iv. With respect to the above (flood risk management proposals), the Proposed Project is therefore compatible with the wider planning objectives of the area. It does not alter the flood risk upstream or downstream of the Proposed Project site.

7. SSFRA CONCLUSIONS

- A flood risk identification study was undertaken to identify existing potential flood risks associated with the Proposed Project. From this study:
    - No instances of historical flooding were identified in historic OS maps;
    - No instances of recurring flooding were identified on OPW maps within the Site;
    - The GSI Historical 2015/2016 flood mapping indicates that some areas of the Proposed Project site can be affected by surface water flooding;
    - The GSI Groundwater Flood Maps do not record any groundwater flood zones within the Proposed Project site;
    - CFRAM maps for the local area do not show any fluvial flood zones within the Proposed Project site;
    - The National Indicative Fluvial Flood Maps do record some fluvial flood zones within the Proposed Project site and in the vicinity of the Lemanaghan Stream.

- Whilst CFRAM mapping shows significant fluvial flood zones on the Brosna River to the south of the Proposed Project site, these flood extents do not encroach upon Lemanaghan Bog;
- The GSI Historical 2015/2016 flood mapping and the National Indicative Fluvial Flood Mapping records the presence of surface water flooding along the Lemanaghan stream within the Proposed Project site. This is likely to be a combination of fluvial and pluvial flooding due to the flat low-lying nature of the Proposed Project site and the low permeability of the soils and subsoils.
    - However, site surveys reveal that the EPA-mapped Lemanaghan Stream has been heavily modified within the Proposed Project site. Drainage in this area has been modified to facilitate the historic industrial peat extraction activities. A large arterial drain was observed in the area of the mapped watercourse and 2 no. existing pumps are present.
    - We conclude, based on site observations and the high drainage density within the bog at this location, that the actual fluvial food risk is the same across the entire site and it should be mapped in Flood Zone C;
- CFRAM mapping includes modelled flood levels for the 10-year and 100-year flood events on the Lemanaghan stream to the south of the Proposed Project site. These levels range from 44.86 to 44.99m OD and are well above the current outfall pipe elevations which discharge to the Lemanaghan Stream (45.98mOD). Therefore, the risk of fluvial flooding along the Lemanaghan Stream backing up into the site drainage network is very low;
- Site walkover indicates the surface of the cutover bog contains an extensive network of peat drains with surface water outflows from the bogs. This existing drainage network has been reduced the risk of pluvial flooding across much of the Site. However, following periods of intense and prolonged rainfall events localised surface water ponding is still likely to occur in places. Therefore, a freeboard (~0.3m) should be included in the design of each turbine base and along access roads;
- The proposed onsite 220kV substation is particularly sensitive to flooding. Conservative volumetric analysis has determined the peak flood levels at the proposed onsite 220kV substation location site for 100-yr and 1000-yr rainfall events to be 56.1 and 56.45m OD respectively. The primary control in the analysis is the expanse of the northern section of Lemanaghan Bog which needs to fill with pluvial flood water before the area surrounding the proposed onsite 220kV substation can flood. The area surrounding the proposed onsite 220kV substation area drains to the north, and the invert of the outfall

drain to the north of the proposed onsite 220kV substation is the bog is 53.42mOD (with a SWL of ~54.0mOD, i.e. there will be positive drainage from the proposed onsite 220kV substation area). It is therefore recommended to give the proposed onsite 220kV substation a formation level of >56.75mOD (56.45mOD + 0.3m freeboard). At this elevation the risk of flooding at the proposed onsite 220kV substation is negligible;

- It may be considered that the Proposed Project can be categorised as "Highly Vulnerable Development". Therefore, a justification test has been completed in and concludes that the Proposed Project is designed and laid out in a manner that reduces flood risk, and that there is negligible potential for any increase in flood risk upstream or downstream of the Proposed Project site;
- In addition, the risk of the Proposed Wind Farm contributing to downstream flooding is also very low, as the long-term plan for the Lemanaghan Bog, in which the majority of the Proposed Project site is located, is to retain and slow down drainage from the bogs, and this will result in sections of the Proposed Project site being wetter for longer and therefore promoting more Fen-like conditions; and,
- The overall risk of flooding posed at the Proposed Project site is assessed to be low, and all proposed infrastructure will be located at or above Flood Zone C elevations.

* *

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