Trecelyn Wind Farm

Draft Environmental Statement

Appendix 10A Flood Consequence Assessment

This report was prepared by WSP UK Limited

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Report for

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Executive summary

This Flood Consequent Assessment (FCA) accompanies the Draft Environmental Statement (ES) for the proposed Trecelyn Wind Farm ('Proposed Development') located near Newbridge. It has been prepared in line with Welsh planning policy (principally the Welsh Assembly Government's (WAG) TAN15) and associated guidance to a) assess the consequences of flooding from all sources both during the construction and operational phases of development; and b) to appraise the potential effects of the scheme on the baseline level of existing flood risk to third parties to identify any significant consequences. The Proposed Development comprises four wind turbines, internal access tracks, substation, underground cables and Temporary Construction Compound (TCC). Once constructed, the significant permanent above ground infrastructure would comprise the four turbines and the substation. All temporary construction works associated with the Proposed Development would be removed with the ground being reinstated to a similar condition and elevation as at present.

The Development Advice Map shows that the entire Proposed Development is within Flood Zone A and is therefore deemed to be compatible development as summarised in Section 9 of TAN15 (Summary of Policy Requirements) and no Justification Test is required.

The hydrological baseline has been determined with information from desktop sources and a walkover survey. No watercourses, ponds or springs lie within the Proposed Development area except for two Ordinary Watercourses in the north and one pond in the south of the Proposed Development area. All potential sources of flooding have been considered under this assessment, which has identified that surface water runoff originating from the Proposed Development poses the greatest potential flood risk.

Suitable flood risk management measures have been identified to address the potential risks identified; these include a Water Management Plan for the construction phase, stand-off distances from watercourses, stockpile management and a Detailed Drainage Design for the operational phase. Risks during decommissioning are considered to be very similar to those for construction, albeit disturbance will be more limited as some below-ground infrastructure will be left in-situ. Appropriate permissions and supporting appraisals will be obtained at the time of decommissioning to comply with the then current legislation and guidance. No residual risks were identified following this FCA, as such no additional mitigation measures are required.

For this FCA, an outline approach to drainage has been identified, including indicative discharge locations (discharge to ground and if required supplemented by discharge to surface water), discharge rates (greenfield runoff rates) and Sustainable Drainage Systems (SuDS) attenuation volumes (up to and including the 1% AEP plus 20% and 40% climate change events for the construction and operational phases respectively). Investigation of the viability of infiltration as a means by which surface water runoff could be discharged will be undertaken post-consent, through liaison with Caerphilly County Borough Council (CCBC) as the SuDS Approval Body (SAB) and Lead Local Flood Authority (LLFA) and by undertaking soakaway testing. In the case that the soakaway testing concludes that infiltration is not solely sufficient in managing runoff, and discharge to the watercourses is required, this will be subject to a Consent from Natural Resources Wales (NRW) and/or the SAB and the LLFA.

Implementation of the identified flood risk management measures is considered to be appropriate mitigation to ensure the Proposed Development will be safe for its lifetime, with consideration of the vulnerability of its users, without increasing flood risk elsewhere and, where possible, will reduce flood risk overall.

The FCA concludes that the Proposed Development, together with the proposed flood risk management measures above, will not be subject to an unacceptable level of risk, nor would there be potential increased flood risk elsewhere. As such the Proposed Development is acceptable on flood risk grounds and meets the aims of TAN-15.

Contents

1. Introduction

1.1 Purpose of this Report

1.1.1 This Flood Consequence Assessment (FCA) accompanies the Draft Environmental Statement (ES) for the proposed Trecelyn Wind Farm (the 'Proposed Development') located near Newbridge. This FCA has been prepared in accordance with Technical Advice Note 15: Development and Flood Risk (TAN15)[1].

1.2 Context

1.2.1 In accordance with the TAN15, a FCA is required as the Proposed Development area exceeds 1 ha. The Proposed Development is within an area of very low flood risk from rivers in the Natural Resources Wales (NRW) Flood Map for Planning (Rivers)[2].

1.2.2 This FCA demonstrates how flood risk to the Proposed Development and any increased flood risk to third parties due to that development, would be managed over the lifetime of the development, taking climate change into account.

1.3 Sources of Data and Information

1.3.1 **Table 1.1** summarises sources of data, site plans and maps that have been used to inform this assessment. Data requests have also been undertaken with NRW(**Annex A**).

1.3.2 Further engagement will be undertaken with CCBC to discuss and agree the proposed outline drainage strategy and watercourse crossings and DCWW to discuss and agree the proposed approach for crossing of DCWW's watermain. A summary of the technical engagement will be provided in the final submission of the ES.

Table 1.1 Sources of desktop information used in this assessment

Data	Source	Purpose
Natural Resources Wales Flood Map for Planning	https://flood-map-for-planning.naturalresources.wales/ (accessed June 2023)	For assessment of fluvial and tidal flood risk

[1] The current version of TAN15 dates from 2004. Consultation on an updated version of TAN15 has been completed (April 2023) and the responses are under review. https://www.gov.wales/technical-advice-note-tan-15-development-flooding-and-coastal-erosion - accessed June 2023

[2] Natural Resources Wales Flood Risk Map Viewer (available online Geocortex Viewer for HTML5 (https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer/I; accessed June 2023)

Data	Source	Purpose
Natural Resources Wales Risk of Flooding from Surface Water	https://lle.gov.wales/catalogue/item/RiskOfFloodingFromSurfaceWater/?lang=en (accessed June 2023)	For assessment of surface water flood risk
Natural Resources Wales Flood Risk from Reservoirs	https://flood-map-for-planning.naturalresources.wales/ (Accessed June 2023)	For assessment of reservoir flood risk
BGS Geoindex Onshore – Aquifer Designation	http://mapapps2.bgs.ac.uk/geoindex/home.html (accessed June 2023)	To characterise the underlying aquifers and hydrogeology
British Geological Survey (BGS) Geology of Britain Viewer for geological information	http://www.bgs.ac.uk/data/mapViewers/home.html (accessed June 2023)	To characterise the underlying geology
Cranfield University – LandIS soilscapes viewer for soil classification	http://www.landis.org.uk/soilscapes/ (accessed June 2023)	To characterise the underlying soils
Ordnance Survey (OS) Mapping and Terrain data	Ordnance Survey	To characterise the local region and identify springs, ponds and lakes
Caerphilly County Borough Council (2013) – Local Flood Risk Management Strategy	https://www.caerphilly.gov.uk/caerphillydocs/roads-and-pavements/localfloodriskmgtstrategyapril2013.aspx (accessed July 2023)	To characterise the local flood risk and management measures

Terminology

1.3.3 In this report, the probability of a flood occurring is expressed in terms of Annual Exceedance Probability (AEP), which is the reciprocal of the annual maximum return period. For example, the 100-year flood can be expressed as the 1% AEP flood, i.e., a flood that has a 1% chance of being exceeded in any year.

1.3.4 **Table 1.2** is provided to clarify the use of the AEP terminology as well as a description of the flood band definitions as used by the NRW, and the Welsh Flood Zones set out in the Welsh Assembly Government's Technical Advice Note 15 (TAN-15) Development Advice Map (DAM) and associated guidance.

Table 1.2 Flood Zone definitions and associated annual exceedance probability

WAG TAN-15 DAM Flood Zone*	NRW Flood Bands	AEP	Definition
Development Advice Map (DAM)			
Flood Zone A	Very Low Risk	<0.1% AEP of river or sea flooding	Land with less than 0.1% AEP (1 in 1,000) probability of flooding from rivers or the sea, in any given year
Flood Zone C1 (developed and served by significant flood defences) / Flood Zone C2 (no significant flood defences)	Low Risk	Between 1% and 0.1% AEP of river flooding Between 0.5% and 0.1% AEP of sea flooding	Land with between a 1 in 100 and 1 in 1,000 probability of river flooding in any year; or land having between a 1 in 200 and 1 in 1,000 probability of sea flooding in any year.
Flood Zone B	N/A	N/A	Based upon British Geological Survey drift data
N/A	Medium Risk	Between 3.3% and 1% AEP risk of river flooding / between 3.3% and 0.5% AEP risk of sea flooding	Land having a probability of river flooding of between 1 in 30 and 1 in 100 in any year; or land having a probability of sea flooding of between 1 in 30 and 1 in 200 in any year.
N/A	High Risk	>3.3% AEP of flooding	Land having a 1 in 30 or greater probability of river or sea flooding in any year.
Flood Map for Planning (rivers)			
Flood Zone 1	N/A	<0.1% AEP of flooding	Land with less than 0.1% AEP (1 in 1,000) probability of flooding from rivers or the sea, in any given year
Flood Zone 2	N/A	Between 0.1% and 1% AEP of flooding	Land with 0.1% to 1% (1 in 1000 to 1 in 100) probability of flooding from rivers in a given year, including the effects of climate change.
Flood Zone 3	N/A	>1% AEP of flooding	Land with more than 1% (1 in 100) probability of flooding from rivers in a given year, including the effects of climate change.

WAG TAN-15 DAM Flood Zone*	NRW Flood Bands	AEP	Definition
Flood Map for Planning (surface water and small watercourses)			
Flood Zone 1	N/A	<0.1% AEP of flooding	Land with less than 0.1% AEP (1 in 1,000) probability of flooding from surface water or small watercourses, in any given year
Flood Zone 2	N/A	Between 0.1% and 1% AEP of flooding	Land with 0.1% to 1% (1 in 1000 to 1 in 100) probability of flooding from surface water or small watercourses in a given year, including the effects of climate change.
Flood Zone 3	N/A	>1% AEP of flooding	Land with more than 1% (1 in 100) probability of flooding from surface water or small watercourses in a given year, including the effects of climate change.
Groundwater flood risk			
N/A	N/A	N/A	Flood risk bands assessed by professional judgement, in the absence of criteria set by NRW. High risk: flooding has occurred/mapped or reported significant risk, significant consequences. Medium risk: flooding has occurred/mapped but no significant consequences. Low risk: flooding has not occurred, no significant mapped/reported risk.
Sewer flood risk			
N/A	N/A	N/A	Flood risk bands assessed by professional judgement, in the absence of criteria set by NRW. High risk: flooding has occurred/mapped or reported significant risk, significant consequences.

WAG TAN-15 DAM Flood Zone*	NRW Flood Bands	AEP	Definition
			Medium risk: flooding has occurred/mapped but no significant consequences. Low risk: flooding has not occurred, no significant mapped/reported risk.
Artificial flood risk			
N/A	N/A	N/A	Flood risk assessed on the basis of flood extent shown on NRW Flood Risk from Reservoir Map.

Notes: * Welsh Assembly Government's (WAG) Technical Advice Note 15 (TAN-15) Development Advice Map (DAM)

1.4 Structure of this report

1.4.1 The report is structured as follows:

- **Section 2** - Site description, development proposals and planning context;
- **Section 3** - Flood Risk Appraisal;
- **Section 4** – Outline drainage strategy;
- **Section 5** - Flood Risk Mitigation; and
- **Section 6** - Conclusions.

1.4.2 Figures are presented within each section while supporting documents are presented at the end of the report in the form of appendices. These are as follows:

- **Annex A** contains details of the correspondence and data provided by NRW; and
- **Annex B** contains the calculations of surface water runoff attenuation volumes.

2. Site Description, Development Proposal and Planning Context

2.1 Introduction

2.1.1 This section provides an overview of the Proposed Development area location and characteristics (**Section 2.2**), a description of the Proposed Development (**Section 2.3**) and establishes the planning policy context for the FCA (**Section 2.4**).

2.2 Site Description

The Site

2.2.1 The Proposed Development area lies within the CCBC administrative area on land at Mynydd Maen, near Newbridge.

2.2.2 The current baseline is based on desk based information sources provided in Table 1.1 and observation from a walkover survey carried out by a WSP hydrologist on 21st July 2023. Photographs of the walkover are provided in **Appendix 10B** of **Chapter 10: Water Environment** of the Draft ES.

Land use and topography

2.2.3 The Proposed Development area and surrounding area comprise a mosaic of agricultural fields and woodland which is shown to have remained largely undeveloped since the 19th century. Small developments are present within the Proposed Development boundary, including farms and access tracks. To the west of the Proposed Development is the A467, industrial and residential developments and various active and disused quarries and remains of coal mining. Land to the east is either forestry or rough grassland. The most significant features of transportation are the A467 and A472 roads which bypass the Proposed Development at (minimum) distances of 0.7km and 0.4km, respectively (**Figure 10.1** of the Draft ES).

2.2.4 The Proposed Development is located on the lower hills to the west of the Mynydd Llwyd and Mynydd Maen ridges. The topography generally slopes down from east to west/southwest, into the valleys associated with tributaries to the Afon Ebwy (Nant Gawni and Nant Hafod-fach). The summit of the ridges is 472mAOD, located approximately 1.8km to the east of the Proposed Development (NGR: ST 25950 97835). The lowest elevations within 1.5km of the Proposed Development are associated with the Ebwy valley, which ranges from 110mAOD to the north and 80mAOD to the south **Figure 10.1** of the Draft ES**).**

Hydrology and Drainage

2.2.5 There are no watercourses within the Proposed Development area except for an Ordinary Watercourse (unnamed watercourse tributary of Trosnant Brook which crosses the northern land parcel) and two tributaries of Nant Gawni (culverted below the access road

between the northern and central land parcels) (**Figure 10.1** of Draft ES). These watercourses were all observed to be dry on the walkover survey. The two existing pipe culverts on the tributaries of the Nant Gawni are approximately 40cm in diameter. The culvert in the northern parcel is partially collapsed on the western side (photos in **Appendix 10B** of the Draft ES).

2.2.6 In the area surrounding the Proposed Development, there are two Main Rivers (Afon Ebwy on the western edge and the Trosnant Brook which is a tributary of Afon Lwyd on the northern edge) and several Ordinary Watercourses including the Nant Gawni, Nant Hafod-fach and Nant Gwyddon, which are tributaries to the Afon Ebwy and generally flow to the west **(Figure 10.1** of the Draft ES**)**.

2.2.7 The Afon Ebwy flows from north to south through the Ebwy valley, to the west of the Proposed Development. The Afon Ebwy Fach (Main River) confluences with the Afon Ebwy approximately 4.5km upstream of the Proposed Development; yet as it tracks to the south the only inputs to the Afon Ebwy are from minor tributaries (Ordinary Watercourses) until the confluence with the Afon Sirhowy (Main River) approximately 4km downstream of the Proposed Development.

2.2.8 There are no springs within the Proposed Development area (**Figure 10.1** of the Draft ES). There are eight springs shown in the OS mapping within the 1.5 km of the Proposed Development boundary. Three of the springs are located to the north on the southern slopes of the Cefn Crib which broadly flow to the south into a minor tributary of the Afon Ebwy. A fourth spring is located to the west on the Craig Swffryd slopes, which flows to the west, directly towards the Afon Ebwy. Four springs located to the southeast which feed several of the headwaters of the Nant Gwyddon.

2.2.9 There are 13 ponds located within 1.5 km of the Proposed Development, with one falling within the Proposed Development site area near turbine 3.

2.2.10 **Table 2.1** below summarises the hydrological baseline for the individual Proposed Development land parcels.

Table 2.1 Summary of baseline hydrology conditions across the Proposed Development

Proposed Development land parcel	Baseline hydrology summary
Northern	Located entirely within Afon Ebwy catchment, which flows approximately 1.4km to the west of the land parcel. The land parcel intersects the Nant Gawni, an ordinary watercourse and tributary of the Afon Ebwy, and one tributary (unnamed watercourse) of the Trosnant Brook. There are no identified ponds or springs within the land parcel but there are 7 ponds and 5 springs within 1.5 km of the Proposed Development.
Central	Located entirely within the Afon Ebwy catchment, which flows 1.9 km to the west of the land parcel. The land parcel does not intersect any identified watercourses, ponds, or springs. The nearest hydrology feature is the Nant Hafod-fach, (tributary of Afon Ebwy) which is located 0.2km to the west of the land parcel. There are 8 ponds and 2 springs within 1.5km of the Proposed Development.

Southern	Located entirely within the Afon Ebwy catchment, which flows 0.8km to the west of the land parcel. The land parcel does not intersect any watercourses. The closest watercourses (Ordinary Watercourses), Nant Hafod-fach and Nant Gwyddon, are tributaries of Afon Ebwy which flow 0.2km to the west and 0.3km to the east of the land parcel respectively. There is one pond within the land parcel, identified as Pwllgwinau in the OS mapping (NGR: ST 23144 96403). The pond is approximately 0.03km² in area and at an elevation of around 345mAOD. There are no identified springs located within the Proposed Development area. There are 9 ponds and 4 springs within 1.5km of the Proposed Development.

Geology, Hydrogeology and Soils

2.2.11 The LandIS Soilscapes map indicates that the soil type within the Proposed Development area predominantly comprises freely draining acid loamy soils over rock, with a loamy texture and medium carbon content. In the northeast of the Proposed Development area there is an area shown as having very acid loamy upland soils with a wet peaty surface, a peaty texture and high carbon content.

2.2.12 A Phase 1 peat depth survey was undertaken by WSP in 2021 and is provided in **Chapter 11: Ground Conditions** of the Draft ES. Based on the findings of the survey, which reported minor peat depths up to 0.01m thick, it was concluded that peat is not present across the Proposed Development area.

2.2.13 The BGS online geology mapping indicates that there are no superficial deposits within the Proposed Development area. In the surrounding area there is very limited superficial deposits area, and where these are present are consistent with the valley floors. The Afon Ebwy flows across Alluvium (clay, silt, sand, and gravel) and occasional Glaciofluvial Deposits (sand and gravel). The lower reaches of Nant Gawni (tributary of Afon Ebwy) are underlain by Head Deposits (clay, silt, sand and gravel). The Trosnant Brook is underlain by Head (clay, silt and gravel) and Alluvium (clay, silt, sand, and gravel) superficial deposits, the latter of which is characteristic of the Afon Lwyd valley.

2.2.14 The Proposed Development and surrounding area are underlain by the Carboniferous South Wales Upper Coal Measures Formation, which is described as coal-bearing mudstone/siltstones with seat-earths and minor grey sandstones, coals, and ironstones. The South Wales Upper Coal Measures Formation is comprised of the Hughes Member (sandstones with small, localised areas of mudstone and siltstone) which underlies the Proposed Development area and Rhondda Member (Pennant Sandstones with thin mudstone/siltstone and seat-earth interbeds and mainly thin coals) which underlies the Afon Ebwy and Nant Gwyddon valleys. BGS borehole logs within the study area show the geology to consist of dark grey gritstone with coal and clay layers, fractured and weathered in places.

2.2.15 The South Wales Upper Coal Measures and Alluvium deposits are classified by NRW as Secondary A Aquifers which by definition are *"permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers"*. These are generally aquifers formerly classified as minor aquifers.

2.3 Development Proposals

2.3.1 The development proposals incorporate the construction and operation of a wind farm with four turbines and associated infrastructure. The key elements of the Proposed Development are shown in **Figure 10.1** of the Draft ES and listed below. It is therefore proposed that some flexibility for infrastructure micrositing be retained and that appropriate limits of deviation would be up to 50m for turbines and 100m for internal wind farm tracks and other infrastructure such as the substation and site compound. This mitigation may be restricted further in terms of specific locational hard constraints, for example not micrositing closer to a watercourse if within 50m of a watercourse. A more detailed description is provided in **Chapter 4: Description of Proposed Development** of the Draft ES.

- Four wind turbines, each with a three-bladed rotor with a maximum height to blade tip of 145m;
- Access works – approximately 3.46km of site access tracks will be required, which includes 2.4km of new access tracks and 1.06km of existing tracks which will require upgrades. The track construction will be approximately (~)5m wide, ~0.6m deep (dependent of ground conditions), with a ~2m grass verge either side;
- Crane pads at each turbine location, sized to suit the turbine manufacturers requirements (typically 2500m^2);
- Turbine foundations, typically comprising of a reinforced concrete slab with dimensions of approximately 20m x 4m depth;
- Underground power cables linking the turbines and the on-site substation, with a typical trench width of 450mm and depth of 750mm. To minimise ground disturbance, cables will be routed alongside the roads connecting each parcel of land;
- TCC (maximum area of 2500m^2), laydown, and storage areas; and
- On-site substation with an approximate area of 14m x 10m.

2.3.2 The Proposed Development will be designed with an operational life of 30 years. At the end of this period the developer has two options; to decommission the wind farm and dismantle and remove the turbines; or to apply for an extension to the operating period using existing equipment or by installing new equipment on the Site. For the purposes of this assessment, it is assumed that the wind farm would be decommissioned.

2.4 Planning Context

Introduction

2.4.1 The purpose of this section is to identify the key policy documents that define the scope of this assessment. The section is structured in a hierarchical order, from national policy down to local guidance.

National Policies

Technical Advice Note 15 (TAN15)

2.4.2 Technical Advice Note 15: Development and Flood Risk (TAN15 – July 2004)[3] was produced by the then Welsh Assembly Government (now the Welsh Government). TAN15 provides technical guidance which supplements the policy set out in Planning Policy Wales (Edition 11, December 2018) (Welsh Assembly Government, 2018[4]) in relation to development and flooding, providing a framework within which risks arising from both river and coastal flooding, and from additional runoff from development in any location, can be assessed. Consultation on an updated version of TAN15 has been completed (April 2023[5]). The draft update includes a range of changes to the guidance, in particular it removes reference to the Development Advice Map (DAM) and refers to a Flood Map for Planning (FMfP) held by NRW. However, the consultation draft clearly states that TAN15 (2004) remains current until such a time that the replacement is confirmed. TAN15 (2004) has therefore been used to underpin this assessment.

2.4.3 The updated FMfP mapping and Flood Risk Assessment Wales Map have been used as a further reference point for the assessment of flood risk to the Proposed Development, given that this is understood to be a more contemporary dataset utilising the latest and improved datasets.

The National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in Wales, Welsh Government

2.4.4 The National Strategy for FCERM in Wales[6], as required under the Flood and Water Management Act 2010, set out the management approach for risks associated with flooding and coastal erosion across Wales over a 10-year period. NRW are responsible for managing the flood risks from the main rivers and sea across Wales; whilst Local Authorities LLFAs are responsible for managing risks associated with surface water, groundwater, and ordinary watercourses.

Sustainable Drainage (SuDS) Statutory Guidance, Welsh Government

2.4.5 The SuDS Statutory Guidance[7] establishes the requirements of Schedule 3 of the Flood and Water Management Act 2010; a framework for the approval and adoption of surface

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[3] Welsh Government. 2004. *Technical Advice Note 15: Development and Flood Risk*. Planning Policy Wales. (Online) Available from: https://gov.wales/sites/default/files/publications/2018-09/tan15-development-flood-risk.pdf (Accessed June 2023).

[4] Welsh Assembly Government. 2018. *Planning Policy Wales.* (Online) Available from: https://www.gov.wales/planning-policy-wales (Accessed June 2023)

[5] Welsh Government. 2023. *Technical Advice Note 15: Development, flooding and coastal erosion - further amendments.* (Online) Available from: https://www.gov.wales/technical-advice-note-tan15-development-flooding-and-coastal-erosion-further-amendments-html (Accessed June 2023)

[6] Welsh Government. 2010. The National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in Wales. (Online) Available from: https://gov.wales/sites/default/files/publications/2021-03/the-national-strategy-for-flood-and-coastal-erosion-risk-management-in-wales.pdf (Accessed June 2023)

[7] Welsh Government. 2019. *Sustainable Drainage (SuDS) Statutory Guidance*. (Online) Available from: https://gov.wales/sites/default/files/publications/2019-06/statutory-guidance.pdf (Accessed June 2023).

water management systems serving new developments. The SuDS Approval Bodies (SABs) are assigned under the same Act, which give local authorities the responsibility to approve drainage systems for new developments. The overall objective of the legislation is to deliver effective, multi-purpose SuDS, which would remain effective for the lifetime of the development.

Local plans and policies

2.4.6 Local plans and policies and relevant guidance to this FCA are summarised in **Table 2.2**

Table 2.2 Local Plans, policies and guidance

Policy/ Plan / Guidance	Key Provisions
Local Flood Risk Management Strategy, Caerphilly County Borough Council (CCBC) (2012)[8]	The Caerphilly County Borough Council (CCBC) Flood Risk Management Strategy (FRMS) sets out the responsibilities of the LLFA to address 'local' flood risks from ordinary watercourses, surface water and groundwater. The strategy is used by CCBC to co-ordinate flood risk management across the region. The FRMS has been used to inform Section 3 of this report.
Flood Risk Management Plan, Caerphilly County Borough Council (CCBC) (2015)[9]	The CCBC Flood Risk Management Plan (FRMP) identifies that the primary sources of flood risk within Crumlin and Newbridge are blocked gullies, culverts and storm sewers. Flooding from the Afon Ebbw and ordinary watercourses is cited as another significant source of flooding in these regions.
Local Flood Risk Management Strategy, Torfaen County Borough Council (TCBC) (2013) [10]	The TCBC FRMS sets out the responsibilities of the TCBC to address 'local' flood risks from ordinary watercourses, surface water and groundwater. The strategy is used by TCBC to co-ordinate flood risk management across the region. The FRMS has been used to inform Section 3 of this report.
Flood Risk Management Plan, Torfaen County Borough Council (TCBC) (2015) [11]	The TCBC FRMP identifies the key sources of flood risk within the borough as being fluvial flooding associated with the Afon Llwyd and surface water flooding in urban areas. The FRMP sets out how risk management authorities will work to manage flood risk.

[8] Caerphilly County Borough Council (CCBC). 2012. Local Flood Risk Management Strategy, (Online) Available at: https://www.caerphilly.gov.uk/caerphillydocs/council-and-democracy/flood-risk-management-strategy/environmental_report.aspx (Accessed August 2023)

[9] Caerphilly County Borough Council (CCBC). 2015. Flood Risk Management Plan. (Online). Available at: https://www.caerphilly.gov.uk/caerphillydocs/roads-and-pavements/flood-risk-mgt-plan-dec2015.aspx (Accessed August 2023)

[10] Torfaen County Borough Council. 2013. Local Flood Risk Management Strategy. (Online) Available at: https://www.torfaen.gov.uk/en/Related-Documents/Roads-Highways-and-Pavements/Drainage/TorfaenLocalFloodRiskManagementStrategy.pdf (Accessed June 2023)

[11] Torfaen County Borough Council. 2015. Flood Risk Management Plan. (Online) Available at: https://www.torfaen.gov.uk/en/Related-Documents/Roads-Highways-and-Pavements/Drainage/Torfaen-Flood-Risk-Management-Plan.pdf (Accessed June 2023)

Policy/ Plan / Guidance	Key Provisions
Sustainable Drainage Approval Body (SAB), Caerphilly County Borough Council (CCBC) (2021)[12]	CCBC undertake the SAB technical approvals on behalf of TCBC. At present, CCBC have not produced any technical guidance on sustainable drainage design or standards. However, the application guidance does make reference to the key national documents listed above
Severn Preliminary Flood Risk Assessment (PFRA), Natural Resources Wales (NRW) and the Environment Agency (EA) (2018)[13]	The Severn PFRA was undertaken in December 2018. The document is used to inform management of the River Severn catchment in regard to flood risk and FRMPs developed by Local Authorities within the catchment. The catchment area is inclusive of the Blaenau Gwent County Borough.

2.5 The Justification Test

2.5.1 TAN15 directs that preference to siting projects within Zone A must be given, then to Zone B where flooding from fluvial or tidal sources will be less of an issue. Projects should be directed away from Zone C, although where this is not possible the project will be subject to the tests set out in Sections 6 and 7 of TAN15.

2.5.2 The DAM (**Figure 10.2** of the Draft ES) shows that the entire Proposed Development is within Flood Zone A (see section 1.3 for DAM Zone definitions) and is therefore deemed to be compatible development as summarised in Section 9 of TAN15 (Summary of Policy Requirements). The FCA and mitigation measures will need to demonstrate that there is no increase in flood risk elsewhere and consideration of the surface water requirements.

2.5.3 The vulnerability of the Proposed Development elements and Flood Zone compatibility is presented below.

Table 2.3 Application of the TAN15 policy requirements

Development type	Flood risk vulnerability classification	Flood Zones[1]	Flood risk vulnerability and flood zone 'compatibility'
Construction Phase			
Temporary construction compound (including offices and welfare facilities)	Less Vulnerable	A	✓ (No Justification Test required)

[12] Caerphilly CBC. 2021. Sustainable Drainage Approval Body (SAB). (Online) Available at: https://www.caerphilly.gov.uk/sab (Accessed June 2023).

[13] Natural Resource Wales. 2018. Severn Preliminary Flood Risk Assessment. (Online) Available at: https://cdn.naturalresources.wales/media/687716/pfra-severn.pdf (Accessed June 2023).

Development type	Flood risk vulnerability classification	Flood Zones[1]	Flood risk vulnerability and flood zone 'compatibility'
Construction and working areas	Less Vulnerable	A	✓ (No Justification Test required)
Operational Phase			
Wind turbines	Highly Vulnerable	A	✓ (No Justification Test required)
Substation	Highly Vulnerable	A	✓ (No Justification Test required)
Internal access tracks	Less Vulnerable	A	✓ (No Justification Test required)

Notes:

✓ Development is appropriate

✗ Development should not be permitted

[1] Definition of flood zones is provided in **Table 1.1**

3. Flood Risk Appraisal

3.1 Introduction

3.1.1 The assessment will use the source-pathway-receptor approach, whereby all three of those elements must exist for these to be a risk to be assessed. The presence of a source is initially screened in **Section 3.2** below. Where a potential source is identified, the risk itself will be assessed with respect to the likelihood and consequence of flooding in the subsequent sub-sections. Where necessary, appropriate flood risk management measures will be set out in **Sections 4** and **5** to address the identified risks.

3.2 Screening of all Potential Sources of Flood Risk

3.2.1 **Table 3.1** provides an initial screening of all potential flood risk across the Proposed Development. Those that are screened in as posing a potential flood risk are then considered in the following sub-sections.

Table 3.1 Screening of all Potential Flood Risk Sources

Source of Flooding	Potential Connection to Proposed Development	Screened In?
Fluvial	The DAM (**Figure 10.2** of the Draft ES) and FMfP (**Figure 10.3** of the Draft ES) show that the Proposed Development lies within an area of very low risk of fluvial flooding (Flood Zone A in the DAM and Flood Zone 1 in the FMfP). Fluvial flooding is assessed in further detail in **Section 3.4.**	Yes
Tidal	The Proposed Development is located over 15km from the sea and is at an elevation exceeding 290m AOD. Owing to the lack of source, the risk of tidal flooding in the area is considered to be low and is not considered further in this assessment.	No
Surface water	The Flood Risk Assessment Wales map – Flood risk from surface water and small watercourses (**Figure 10.4** of the Draft ES) shows that the majority of the Proposed Development is at very low risk of flooding (<0.1% AEP) from this source. Small areas of low to high flood risk (Flood Zones 2 and 3, 0.1% to >3.3% AEP) are shown on localised lower-lying areas which include small watercourses (Nant Gwyddon, Nant Hafod-fach and Nant Gawni) and ponds. Surface water runoff originating from the Proposed Development area also needs further consideration. Surface water flooding is assessed in further detail in **Section 3.5.**	Yes

Source of Flooding	Potential Connection to Proposed Development	Screened In?
Groundwater	The Proposed Development is underlain by South Wales Upper Coal Measures which consists of a cyclical sequence of sandstone, mudstone, siltstone and coal seam layers (Secondary A aquifer). Groundwater flooding is assessed in further detail in **Section 3.6.**	Yes
Sewer	The Proposed Development is primarily situated away from developed areas (due to its elevation). However, the proposed access track crosses a DCWW watermain (expected at two locations). The risk of sewer flooding is therefore considered further in **Section 3.7.**	Yes
Artificial	The NRW Reservoir Flood Risk Map (**Figure 10.5** of the Draft ES) shows that the Proposed Development is not located within an area of reservoir flood risk. In the wider area, flooding from artificial sources is predicted along the Afon Ebwy associated with breach/failure of reservoirs to the north of the Proposed Development. No raised bodies of water are proposed as part of the development. Owing to the lack of source, the risk of artificial flooding in the area is considered to be low and is not considered further in this assessment.	No

3.3 Historical Flooding

3.3.1 Historical flood extent mapping received from NRW indicates that there are no recorded flood incidents within the Proposed Development area. There is evidence of historical flooding in the centre of Newbridge, in the surrounding area, resulting from exceeded capacity of the Afon Ebbw.

3.4 Fluvial Flooding

3.4.1 The DAM shows that the Proposed Development area is located entirely within Flood Zone A (little or no risk of fluvial flooding) (**Figure 10.2** of the Draft ES). The NRW's FMfP for Rivers (**Figure 10.3** of the Draft ES) shows that the Proposed Development area is located entirely within Flood Zone 1; and is therefore at very low probability of flooding from these sources (<0.1% AEP). The closest areas of higher flood risk (FMfP Flood Zones 2 / 3 or DAM Flood Zones B / C) are associated with the Afon Ebwy 700m to the west, the Nant Gwyddon 525m to the south and the Trosnant Brook 950m to the north of the study area. This mapped fluvial flooding follows ground at an elevation of 90 to 130mAOD, well below the elevation of the Proposed Development (290 to 410mAOD).

3.4.2 It is noted that fluvial flood mapping only maps the flood risk associated with the larger watercourses, as such the small watercourses within the study area do not have mapped fluvial Flood Zones. For these watercourses, the Surface Water Flood Risk map (**Figure 10.4** of the Draft ES) provides an indication of the extent of flood risk.

3.4.3 On the basis of the Flood Zone classification and elevation of the Proposed Development, the assessed risk of fluvial flooding is considered to be low.

3.4.4

3.5 Surface Water Flooding

Surface water run-on

3.5.1 The FMfP for Surface Water and Small Watercourses (**Figure 10.4** of the Draft ES) indicates that the majority of the Proposed Development (and surrounding area) is at very low risk of flooding (Flood Zone 1, <0.1% AEP) from surface water. This is reflective of the general topography of the Proposed Development and locality across a ridge summit. Small areas of low to high flood risk (Flood Zones 2 and 3, 0.1% to >3.3% AEP) are shown on localised lower-lying areas which include small watercourses (Nant Gwyddon, Nant Hafod-fach and Nant Gawni) and ponds. All of the Proposed Development elements are within Flood Zone 1. A summary of the baseline surface water flood risk across the Proposed Development land parcels is provided in **Table 3.2**.

Table 3.2 Summary of the baseline surface water flood risk for the Proposed Development

Proposed development land parcel	Surface water flood risk summary
Northern	Entirely within area of very low risk of flooding from surface water (Flood Zone 1, <0.1% AEP) except for minor flowpath of low to high flood risk (Flood Zones 2 and 3, 0.1% to >3.3% AEP) originating on the southern edge of the land parcel (unnamed tributary of the Nant Gawni).
Central	Entirely within area of very low risk of flooding from surface water (Flood Zone 1, <0.1% AEP).
Southern	Entirely within area of very low risk of flooding from surface water (Flood Zone 1, <0.1% AEP) except for minor localised areas of low to high risk (Flood Zones 2 and 3, 0.1 to >3.3% AEP) which are associated with a pond (Pwllgwinau) and minor flowpath originating on the western edge of the land parcel (unnamed tributary of the Nant Hafod-fach).

3.5.2 The proposed access tracks intersect mapped Ordinary Watercourses within Flood Zone 1 at three locations. One of the locations relate to a new coring (WC1) and two of the locations relate to existing crossings (WC2 and WC3). Indicative crossing points identified based on review of the FMfP, satellite imagery and site visit observations are outlined in **3** and shown on **Figure 10.1** of the Draft ES. Photographs and observations of the crossing locations and existing culverts are provided in **Appendix 10B** of the Draft ES.

Table 3.3 Indicative crossings of Ordinary Watercourses

ID	NGR	FMfP – Flood Zone	Comments
Access track crossings			
WC1	ST 23862 98089	Flood Zone 1	New access track with crossing of unnamed watercourse, tributary of Trosnant Brook.
WC2	ST 23611 98000	Flood Zone 1	Existing access track crossing of Nant Gawni headwaters. Partially collapsed pipe culvert underneath access road (diameter ~40cm).
WC3	ST 23530 97371	Flood Zone 1	Existing access track crossing of drain that connects to the Nant Gawni headwaters. Pipe culvert underneath the access road

3.5.3 The new proposed crossing point (WC1) has the potential to impact on flow conveyance and increase local flood risk. Potential mitigation to assist in conveying flows (consistent with the existing flow pathway) is discussed in **Section 5.**

3.5.4 Existing access tracks and crossing points (WC2 and WC3) may be subject to modifications associated with access track improvements or following detailed survey (post consent), should an upgrade be deemed necessary as a result of structural considerations. Mitigation to ensure that any track updates and widening would have no impact to the existing flow conveyance is discussed in **Section 5**.

Surface water runoff

3.5.5 The temporary and permanent changes in ground cover associated with the Proposed Development have the potential to increase the overall extent of lower permeability surfaces. In the absence of effective surface water management measures, this could lead to a temporary increase in peak runoff rates and a consequent increase in flood risk to third party receptors downstream. To address this, surface water management measures will be implemented, as discussed in **Sections 4** and **5**.

3.5.6 For the construction phase, such changes in ground cover would be associated with the wind turbine crane pads, TCC and internal access tracks. For the operational phase such changes would be associated with the crane pads (parking space), substation and internal access tracks (TCC would be restored to its land previous use).

3.5.7 The flood risk receptors associated with the potential effects of increased runoff from the Proposed Development are identified below and shown in **Figure 10.6** of the Draft ES. These have been considered based on review of existing surface water flood risk, proximity to the Proposed Development, and review of topography to determine whether detrimental impacts arising from the development could impact the receptor.

- Residential properties, industry/business properties located in and around Hafodyrynys (FR1);

- Residential properties, industry/business properties located in and around Swffryd (FR2);
- Residential properties, industry/business properties located in and around Newbridge (FR3);
- Residential properties, industry/business properties located in and around Old Pant Road, Pantside (FR4);
- Residential properties, industry/business properties located in and around Abercarn (FR5);
- Residential and farm buildings at Ty Oakley Farm (FR6);
- Residential and farm buildings at Pen y Caeau Farm (FR7);
- Residential and farm buildings at Cefn-rhos-y bed-uchaf (FR8);
- Residential and farm buildings at Blaengawney Farm (FR9);
- Residential and farm buildings at Cil Lonydd Farm (FR10);
- Residential and farm buildings at Glan Shon Farm (FR11);
- Residential and farm buildings at Cefn Rhyswg Farm (FR12);
- Roxburgh bungalow (FR13);
- Residential and farm buildings at Ty Richard Jones farm (FR14);
- Residential and farm buildings at Cefn Crib Farm (FR15);
- Pontbren Cottages (FR16);
- Residential and farm buildings at Cwm Farm (FR17);
- Residential and farm buildings at Pen y Caea u Farm (FR18); and
- Brook Bungalow (FR19).

3.6 Groundwater flooding

3.6.1 Groundwater flooding occurs as a result of water issuing to the surface from the underlying aquifers. This tends to occur after long periods of sustained high rainfall, with areas most at risk being situated on permeable geology and low-lying compared to the local water table.

3.6.2 The BGS mapping indicates that there are no superficial deposits in the Proposed Development area. The Hughes Member bedrock underlying the Proposed Development is designated as a Secondary A aquifer and comprises sandstones/gritstones containing localised units of mudstone, clay and siltstone and with permeability likely to be enhanced by fractures. As the Proposed Development occupies a hilltop location between two deeply incised valleys with no expression of shallow groundwater (e.g., springs or wells), it suggests that the geology is relatively permeable, and the groundwater table lies at depth.

3.6.3 Where groundwater may be encountered, it is likely to be perched and in small quantities. This is due to the Proposed Development area being at a topographic high and the underlying geology comprising bands of both higher and lower permeability bedrock

layers. The CCBC Local Flood Risk Management Plan[14] indicates that groundwater flooding is not considered a significant issue the Abercarn area which includes the Proposed Development area.

3.6.4 Overall, this suggests that there is low likelihood of encountering groundwater during excavation activities associated with the Proposed Development construction; and where groundwater is encountered it will likely be in small quantities and is not considered to be a significant source of potential flood risk.

3.7 Sewer Flooding

3.7.1

3.7.2 The Proposed Development is situated away from developed areas. It is anticipated that there are no/few sewer drainage networks within the Proposed Development area within which water levels could feasibly rise to an extent that would result in flooding of the area. Any flows surcharging from minor sewer systems associated with nearby farm buildings (e.g., Glan-Shon Farm within the southern land parcel) would be expected to be minimal/intercepted by the local watercourses. In the surrounding area, sewer drainage networks serve the towns/villages of Trecelyn and Abercarn, but these are at significantly lower elevations (less than 210mAOD) than the Proposed Development (higher than 290mAOD).

3.7.3 Information provided by DCWW as part of the EIA Scoping Direction (**Table 10.4** of **Chapter 10: Water Environment** of the Draft ES) indicates that the proposed access track in the northwestern edge of the Proposed Development crosses a watermain (expected at two locations) (**Figure 10.6XX** of the Draft ES). Specific mitigation measures are outlined in **Section 5** to mitigate the risk of interference with the watermain. Based on topographic levels, it is envisaged that potential flooding originating from breach or surcharge of the watermain would drain west, eventually discharging into Afon Ebwy.

3.7.4 The risk of sewer flooding, with the proposed embedded measures, is assessed to be low.

3.7.5

[14] Caerphilly County Borough Council (2015) Local Flood Risk Management Plan. (Online) Available from: https://www.caerphilly.gov.uk/caerphillydocs/roads-and-pavements/flood-risk-mgt-plan-dec2015.aspx. Accessed 30/10/23.

4. Outline Drainage Strategy

4.1 Introduction

4.1.1 This section sets out the outline strategy for managing runoff from the Proposed Development in a sustainable manner, in accordance with the requirements to manage surface water flood risk on-site, not increase flood risk elsewhere, and where possible, reduce flood risk overall. Surface water quality matters are addressed in **Chapter 10: Water Environment** of the Draft ES.

4.2 Overview of Drainage Strategy Scope

4.2.1 The need for sustainable surface water management for the Proposed Development is set out in TAN15**Error! Bookmark not defined.**, Sustainable Drainage (SuDS) Statutory Guidance[7] and the Defra Non-Statutory Technical Standards for Sustainable Drainage Systems[15]. Best practice guidance is provided in the CIRIA SuDS manual[16]. At the local level, guidance is provided by CCBC as the LLFA in the following documents: Local Flood Risk Management Strategy (2012)[9] and Flood Risk Management Plan (2015)[10].

4.2.2 The creation of the hardstanding surfaces associated with the buildings and vehicle movement areas within the Proposed Development area has the potential to increase surface water runoff rates, volumes and pathways. Appropriate management of surface water will therefore be necessary to ensure risks to on-site and off-site (down-gradient) third party receptors are appropriately addressed.

4.2.3 A water management system will be designed for the Proposed Development to address surface water runoff (surface water originating from within the Proposed Development); surface water run-on (surface water originating from outside of the Proposed Development, if any); and any water ingress into the excavations (which it is anticipated would be managed alongside surface water runoff).

4.3 SuDS - Legislation and Guidance

Technical Advice Note 15 (TAN15)

4.3.1 Technical Advice Note 15: Development and Flood Risk (TAN15 – July 2004) provides a framework within which risks arising from both river and coastal flooding, and from additional run-off from development in any location, can be assessed. It encourages the use of SuDS to manage surface water.

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[15] Defra. 2015. *Sustainable Drainage Systems Non-statutory technical standards for sustainable drainage systems*. (Online) Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf (Accessed June 2023).

[16] CIRIA. 2015. CIRIA SuDS Manual. (Online) Available from: https://www.ciria.org/ItemDetail?iProductCode=C753F&Category=FREEPUBS (Accessed June 2023).

Floods and Water Management Act, 2010

4.3.2 Under the Floods and Water Management Act 2010, CCBC is designated as the LLFA and therefore are a statutory consultee on major planning applications in relation to surface water drainage.

Sustainable Drainage (SuDS) Statutory Guidance, Welsh Government

4.3.3 The SuDS Statutory Guidance establishes the requirements of Schedule 3 of the Flood and Water Management Act 2010; a framework for the approval and adoption of surface water management systems serving new developments. The SAB (CCBC) is assigned under the same Act, which give local authorities the responsibility to approve drainage systems for new developments. The overall objective of the legislation is to deliver effective, multi-purpose SuDS, which will remain effective for the lifetime of the development.

CIRIA SuDS Manual (C753)

4.3.4 The CIRIA SuDS (C753) is the most up-to-date industry standard containing revised principles and technical advice for the planning, design, construction, management and maintenance of effective SuDS. This document replaces the original CIRIA SuDS Manual (C697). As the LLFA, CCBC expect all new or existing developments be designed to align with the revised (C753) manual.

DEFRA Non-statutory technical standards for sustainable drainage systems, 2015

4.3.5 The Non-statutory technical standards for sustainable drainage systems is a national guidance document that provides a set of standards to be applied when designing SuDS systems for any development. Standards include controls on peak flow and volume of run-off and flood risk internal to the development and downstream. Standards S2, S4, S7, S8 and S9 state:

- S2 – for greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100-year rainfall event should never exceed the peak greenfield runoff rate for the same event;
- S4 - where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100-year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event;
- S7 – the drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the Proposed Development for a 1 in 30-year rainfall event;
- S8 - the drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100-year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development; and

- S9 - The design of the Proposed Development must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1-in-100-year rainfall event are managed in exceedance routes that minimise the risks to people and property.

LLFA and SAB Advice

4.3.6 Consultation with CCBC will be undertaken to discuss and agree the proposed Outline Drainage Strategy.

Compatibility of SuDS with Site conditions

4.3.7 The Proposed Development is almost entirely greenfield, with some surfaced access tracks and isolated farm buildings distributed across the Proposed Development. Existing greenfield rates of surface water runoff should be maintained in future via the provision of appropriate SuDS.

4.4 The proposed SuDS solution

4.4.1 All potential SuDS options suitable for this environment have been considered. At this stage it is anticipated infiltration may need to be combined with a positive discharge into a watercourse. Investigation of the viability of infiltration as a means by which surface water runoff could be discharged will be undertaken post- consent, through liaison with CCBC and by undertaking infiltration testing. Should infiltration testing results indicate that the ground conditions are not favourable, then attenuation will be included to limit peak discharge rates entering the existing watercourses to the greenfield runoff rate.

4.4.2 Initial estimations of existing greenfield runoff rates and surface water runoff attenuation volumes required have been calculated using Micro Drainage Source Control (2018.1.1) and the UKSuDS tools[17] with results provided in **Annex B**. The existing greenfield runoff rates per hectare (ha) are summarised in **Table 4.1.**

Table 4.1 Existing Greenfield Runoff Rates

Parameter	Value
Area	1 ha
Soil Type	3
SPR (Standardised Percentage Runoff)	0.37
SAAR (Standard Annual Average Rainfall)	1447 mm

[17] HR Wallingford 2022. UKSuDS tools for sustainable drainage systems (online). Available at: https://www.uksuds.com/ (Accessed June 2023)

Parameter	Value
Greenfield Runoff Rates	**Value**
Q_{BAR}	6.72 l/s/ha
1 in 1 year	5.91 l/s/ha
1 in 30 year	11.96 l/s/ha
1 in 100 year	16.53 l/s/ha

4.4.3 Initial drainage calculations supporting this outline strategy have considered the 1% AEP (1 in 100-year) event as the design standard, including allowances for climate change covering the lifetime of the Proposed Development (20% for the construction phase (precautionary upper estimate up to the 2050s) and 40% for the operation phase (precautionary upper estimate up to the 2080s))[18].

4.4.4 The proposed attenuation features will use soft-engineering approaches to flow control rather than use any proprietary systems. It is proposed to discharge at the estimated Q_{BAR} rate of 6.7 l/s per ha. The indicative proposed SuDS solutions for each design element are described in **Table 4.2.**

4.4.5 Wherever possible, drainage systems implemented for the temporary construction phase will be retained and re-used to support the operational drainage system to reduce the impact to existing site conditions. Further consideration to this will be undertaken at the detailed design phase.

Table 4.2 Indicative proposed SuDS Solution

Proposed Development element	Indicative SuDS
Construction phase	
TCC	Permeable sub-base (uncompacted Type 3 stone) to be used, with a minimum depth of 200mm, across the entire compound. If infiltration rates are favourable, then surface water will infiltrate at source, whilst being attenuated in the stone voids during severe storm events. If an outlet is required, then a perforated pipe will collect water within the stone and direct it towards the nearest open channel, alongside the access track.

[18] Welsh Government 2021. Flood Consequences Assessments: Climate change allowances (Online) Available from: https://gov.wales/sites/default/files/publications/2021-09/climate-change-allowances-and-flood-consequence-assessments_0.pdf (Accessed June 2023)

Proposed Development element	Indicative SuDS
	Initial calculations using Micro Drainage 2018.1.1 to support this outline drainage strategy demonstrate that when using a minimum infiltration rate of $1x10^{-5}$ m/s (conservative estimate from CIRIA typical infiltration rates (*The SuDS Manual C753 DEFRA 2015– Table 25.1)*, this system can accommodate the 5% AEP (1 in 20-year) plus 20% climate change without flooding. The results can be found in **Annex B.** Runoff from the roof is proposed to be captured using a rainwater harvesting system for all on-site non potable water usage. Further details will be developed at detailed design stage.
Crane pads	The crane pads will be exposed during the construction period, considered to be up to 6 months in duration. Attenuation is proposed in the form of a ditch downslope of the pad.
Operational phase	
Access tracks	Open channels will be installed on the downslope of the tracks to manage runoff from the tracks and where the land falls towards the tracks, a cut-off ditch will be provided. It is expected that gradients will vary across the Proposed Development Site, therefore it will be necessary to use check dams within the open channels to attenuate flows and promote infiltration. Cross drains would be provided beneath the access tracks surface to convey overland runoff before being discharged into a nearby watercourse. Where collapsed culverts have been identified, these will be replaced on a like-for-like basis unless there is justification for altering the existing flow regime. Calculations using Micro Drainage 2018.1.1 demonstrate that a typical ditch section with a 500-600mm base width, 600mm deep, at a typical gradient of 1:75 will accommodate the runoff from the access tracks for the 1 in 100 year plus 40% climate change without flooding; when using a minimum infiltration rate of $1x10^{-5}$ m/s (conservative estimate from CIRIA typical infiltration rates (*The SuDS Manual C753 DEFRA 2015– Table 25.1)* for the sides and base. The results can be found in **Annex B**. Where the existing ground becomes more level, the ditch sections can be locally widened, and longitudinal gradient slackened to create additional online attenuation. Flow control will be managed with the use of the check dams at suitable intervals along the length of the ditch. The access track leading to turbine 01 is traversed by an existing watercourse, which will require cross drainage (a culvert). This also results in the need to split the surface water catchment of the access, as the length of open channel on the high side will need to discharge into the watercourse if infiltration does not fully drain the runoff. A simple flow control such as a weir will be required at this discharge point to ensure flow rates are managed. The remaining length of open channel on the lower side of the watercourse will continue towards the existing

Proposed Development element	Indicative SuDS
	track, where levels flatten out. It is expected that this will allow for better infiltration performance. The length of existing bridleway PRoW will be used as an access track and the existing drainage will be utilised to accommodate the runoff. Further surveys and assessment of the existing drainage system will be required at detailed design stage to ensure this has sufficient capacity to meet the design requirements. Where the track leads to turbines 03 and 04, the existing ground levels are steep and therefore the drainage system is to account for the steep gradient. As it may be difficult to ensure runoff remains within the open channel, it may be necessary to create a small bund on the downstream side to contain the water. It may also be necessary to utilise the space between the turbines for a shallow storage system, such as a detention basin.
Substation	It is anticipated that runoff from the roof will be collected into an underground water storage tank, which would then be recycled as greywater for re-use in the substation building. If infiltration rates are favourable, then any overflow will be directed towards a nearby infiltrate trench or soakaway. If rates do not allow sufficient infiltration to take place, then interception storage will be considered preferentially, followed by consideration of a connection to the nearest open channel alongside the access tracks. The track inside of the compound will be a permeable sub-base (300mm min. uncompacted Type 3 stone) and the remaining areas will be topsoiled. If infiltration rates are favourable, then surface water will infiltrate at source. If an outlet is required, then a perforated pipe will collect water within the stone and direct it towards the nearest open channel, alongside the access track. Transformers will be individually bunded with sump and pump, and clean water will be discharged locally into a stone trench.
Wind turbines and crane pads	As the turbine pads and crane pads are buried after construction, the runoff from these areas will be similar to the existing situation and therefore a drainage system is not required. Concrete pads will be perforated before being buried to allow percolation of water in heavy rainfall.
Crane pads	The only exposed hardstanding of the crane pad will be associated with a parking space (assumed to be 10m x 3m). The rest of the pad will be covered in topsoil. Attenuation for runoff from the parking space will be provided in the form of a ditch downslope of the hardstanding area.

Pollution control

4.4.6 The proposed SuDS components have been determined in accordance with The CIRIA SuDS Manual C753 to provide the required pollution control of surface runoff prior to infiltration. This indicative SuDS design provides pollution mitigation indices exceeding the minimum required for Low pollution hazard level sites (**Table 4.3**). The indicative

proposals for SuDS components will be confirmed at the detailed design stage and in consultation with the SAB.

Table 4.3 Indicative SuDS components for the Proposed Development

	Description	Pollution hazard level	Pollution mitigation indices		
			TSS	Metals	Hydrocarbons
Land use pollution hazard index* for TCCs, Access Tracks and On-site Substation	***Non-residential car parking with infrequent changes i.e., < 300 traffic movements/day***	***Low***	***0.5 (minimum)***	***0.4 (minimum)***	***0.4 (minimum)***
SuDS component – TCCs and On-site Substation	Permeable paving**	-	0.7	0.6	0.7
Sufficient mitigation?		-	Sufficient	Sufficient	Sufficient
SuDS component – Access Tracks	Swale	-	0.5	0.6	0.6
Sufficient mitigation?		-	Sufficient	Sufficient	Sufficient

Notes: * As defined in Table 26.2 of The CIRIA SuDS Manual C753

** Constructed permeable pavement where a suitable filtration layer is included that provides treatment and including a geotextile at the base separating the foundation from the subgrade) underlain by a soil with good contaminant attenuation potential of at least 300 mm in depth (or equivalent).

4.5 SuDS maintenance

4.5.1 Arrangements will be made for the adoption and future maintenance of the SuDS and drainage assets on the Proposed Development area. An appropriate adopting body will be tasked with this. The exact body will need to be confirmed at the final detailed design stage to comply with then current guidance. Maintenance will be carried out in accordance with the methods and frequency specified in CIRIA's C753 SuDS Manual.

5. Flood Risk Mitigation

5.1.1 Based on the assessment undertaken in **Section 3**, the majority of the Proposed Development is at very low risk of flooding from all sources. The principal flood risk at the Proposed Development is associated with localised sections of the access which cross mapped Ordinary Watercourses (land drains). The assessment indicates the potential for increased flood risk to off-site receptors due to change in permeability as a result of the Proposed Development.

5.1.2 This section outlines key flood risk management measures to ensure the Proposed Development is safe from flooding, and flood risk is not increased to off-site receptors.

Construction and operational phases

5.1.3 The initial flood risk management measures for the construction and operational phases of the Proposed Development are set out in **Table 5.1** and repeated from Table 10.16 of **Chapter 10: Water Environment** of the Draft ES. Those that relate to specific elements or phases are identified in the wording of the measures, or are identifiable by the matter being discussed (e.g., temporary measures will apply to the construction phase only).

Table 5.1 Proposed flood risk management measures for the Proposed Development

Measure reference*	Development element	Flood risk management measure	Reason
1	Working areas, internal access tracks, TCC (construction phase)	**Water Management Plan (WMP)** Implementation of an appropriate Water Management Plan (WMP) for the construction phase of the Wind Farm Development, utilising SuDS principles, including collection, conveyance and attenuation/infiltration storage. Suitable temporary silt fencing, bunding and water quality measures (i.e., silt capture to maintain storage volume) will be included in the design of these works. Sufficient capacity will be provided onsite to hold runoff prior to discharge runoff to ground and/or any water discharge into watercourses is limited to greenfield rates. This would be secured through a planning consent requirement, likely via the CEMP.	To ensure no increase in flood risk downstream of the Proposed Development.
2	Wind Farm Development (operational phase)	**Detailed drainage design** Detailed drainage design for the operational wind farm development, utilising SuDS principles, including attenuation storage where necessary, to ensure sufficient capacity is available onsite to discharge runoff to ground and/or any water discharge into	To ensure no increase in flood risk downstream of the Proposed Development.

Measure reference*	Development element	Flood risk management measure	Reason
		watercourses is limited to greenfield rates. This would be secured through a planning consent requirement.	
3	Working areas, internal access tracks, TCC (construction phase) Wind Farm Development (operational phase)	**Water Discharges** Further investigation of the viability of infiltration as a means by which surface water runoff and, if required, any water accumulating at the base of the excavations (most likely comprising rainfall runoff)) could be discharged to ground will be undertaken through liaison with CCBC and by undertaking soakaway testing exercises. In the case that the soakaway testing concludes that infiltration is not solely sufficient in managing runoff, and discharge to the watercourses is required, this will be subject to a consent from the NRW or CCBC. The water discharge would be suspended if a flood alert or flood warning is in place downstream (and the discharges from the Proposed Development site could feasibly contribute to the flood event). Any discharge to surface water would be restricted to the greenfield runoff rate and will be treated in a suitable basin/trench before discharging.	To ensure no increase in flood risk downstream of the Proposed Development. To ensure that any change in flood risk due to water discharges is limited as far as possible.
4	Working areas (construction phase)	**Standoff distance** No works will be undertaken within 3m of any watercourse (other than for watercourse crossings and drainage mitigation). Any works within 8m of non-tidal Main River will be subject to a Flood Risk Activity Permit (FRAP) from NRW. Any works within 8m of an Ordinary Watercourse will be subject to a Land Drainage Consent (LDC) from CCBC.	This measure will minimise any potential impacts to flow conveyance in the watercourse, particularly during high flow or flood events.
5	Internal access tracks (construction phase)	**Crossing of surface water flow paths/Ordinary Watercourses** Access tracks crossing mapped surface water flow paths or Ordinary Watercourses (proposed at one location) will require appropriately sized culverts to maintain existing flow conveyance. The design of any new culverts will be confirmed as part of the detailed drainage design and be subject to Ordinary Watercourse consent by CCBC.	To convey flows from the mapped surface water flow path beneath the crossing, preventing flooding of the access track.

Measure reference*	Development element	Flood risk management measure	Reason
		Crossing points of any pre-existing structures (expected at three locations) will be surveyed prior to construction works (post consent) to establish the structural integrity of the crossings. Suitable mitigation measures will be identified and proposed, where necessary and applicable, to ensure no detrimental impact to the structure. Should it be deemed necessary for the culvert to be upgraded, any new culverts required will be sized at the detailed design stage in consultation and subject to consent from CCBC.	
6	Working areas - temporary access crossings	**Temporary watercourse crossings** If temporary watercourse crossings are required to enable access over any watercourses, these would be appropriately sized to maintain existing flow conveyance.	Maintain existing conveyance capacity of watercourses
7	Electrical connection (construction phase)	**Underground cables** The underground cables linking the turbines to the substation t will be constructed in discrete sections with the reinstatement process commenced in as short a timeframe as practicable.	Minimise changes in watercourse flow conveyance
8	Working areas (construction phase)	**Topsoil stockpiles** Stockpiles will be appropriately maintained and have the minimum lifespan possible, with materials being reinstated as construction works progress. Where these remain in situ for 3 months or longer, seeding management techniques will be used. Stockpiles will be stored exclusively within areas of very low flood risk (Flood Zone A in the DAM or Flood Zone 1 in the FMfP).	To prevent sedimentation of watercourses and waterbodies (and thus reduction in watercourse flow capacities). To prevent loss of topsoil in a major flood event, thereby reducing the availability of material for reinstatement.
9	Access tracks and working areas (operational phase)	**Temporary components** Once construction is complete, any temporary components (such as working areas) will be removed, and the ground reinstated to preconstruction conditions. Any excavations will be backfilled using soil stockpile materials, slightly above natural ground level to allow for settlement.	To ensure that rainfall infiltration and runoff generation characteristics are returned to preconstruction conditions.

Measure reference*	Development element	Flood risk management measure	Reason
10	Access track (construction phase)	**DCWW water main** A suitable asset protection design for the locations where the proposed access track crosses DCWW's watermain (expected at two locations) will be developed and agreed with DCWW at detailed design stage (post-consent). Site meetings will be held with a DCWW inspector both prior to the construction works commencing (to mark the location and line of the watermain at the proposed crossing locations) and during the access track construction over the watermain.	To prevent damage to and allow maintenance of the DCWW watermain

Decommissioning phase

5.1.4 Relevant flood mitigation measures will be developed once the required works and activities associated with the decommissioning of the Proposed Development are confirmed. It is likely that they will include similar measures as listed above for the construction and operational phases. Specification of such measures must take account of the changes in the flood hazard baseline relating to climate change, change of land-use and regulatory requirements prevailing at the time.

6. Conclusions

6.1.1 This FCA accompanies the ES for the Proposed Development and has been prepared in accordance with the TAN15. The findings of this FCA are summarised below:

- Flood risk to the Proposed Development has been assessed from all potential sources, and the key flood risk to the development is from surface water and fluvial sources. The Proposed Development is considered to be at low risk of flooding from groundwater, sewer, and artificial sources;
- The DAM shows that the entire Proposed Development is within Flood Zone A and is therefore deemed to be compatible development as summarised in Section 9 of TAN15 (Summary of Policy Requirements) and no Justification Test is required.
- Most of the Proposed Development is at very low risk of flooding from surface water flooding, owing to its location on a summit with minimal upstream catchment. There are small areas of high surface water flood risk associated with existing ponds and depressions, and the headwaters of Ordinary Watercourses that intersect the edge of the Proposed Development area. This indicates that, for the most part, it will be surface water runoff originating from the Proposed Development which will be the primary surface water flood risk consideration;
- Runoff from the Proposed Development will be managed to ensure no increase in flood risk downstream of the Proposed Development. A WMP for the construction phase and Detailed Drainage Design will be secured through the CEMP and a planning consent requirement, respectively;
- An outline approach to surface water drainage has been identified and will be agreed with CCBC, including indicative discharge locations (discharge to ground and if required supplemented by discharge to watercourses), discharge rates (greenfield Q_{BAR}) and SuDS attenuation volumes (up to and including the 1% AEP plus 20% and 40% climate change events for the construction and operational phases respectively);
- Investigation of the viability of infiltration as a means by which surface water runoff could be discharged will be undertaken post-consent, through liaison with CCBC and by undertaking soakaway testing. In the case that the soakaway testing concludes that infiltration is not solely sufficient in managing runoff, and discharge to surface water is required, this will be subject to a Consent from the NRW or CCBC; and

6.1.2 The FCA concludes that the Proposed Development, together with the proposed flood risk management measures above, would not be subject to an unacceptable level of risk, nor would there be potential increased flood risk elsewhere. As such the development is acceptable on flood risk grounds and meets the aims of TAN15.

Annex A
Correspondence and data provided by NRW

From:
Sent: 04 October 2023 08:42
To:
Subject: FW: ATI-25713a Trecelyn Wind Farm, Various data required

Follow Up Flag: Follow up
Flag Status: Completed

From: Data Distribution **Sent:** Tuesday, October 3, 2023 2:21 PM
To:
Subject: RE: ATI-25713a Trecelyn Wind Farm, Various data required

Dear ,

Further to your email, please note that unfortunately, the flood map in this area is based on a nationally generated FRAW model, this was last updated in 2020. FRAW modelling uses LIDAR data to generate flood outlines with assumptions made about the channel capacity. This modelling was carried out for the production of flood extents only and is not suitable for detailed site specific assessments, therefore we are not able to provide any flood products for your site.

Apologies we could not have been of any further assistance to you, on this occasion.

Yours sincerely,

Enw /
Teitl swydd / Job title Data Licensing Officer
Adran / Department Customer, Communications and Commercial
Rhif ffôn /
Dyddiau gweithio (os yn berthnasol) / Working days Mon-Fri

Croesewir gohebiaeth yn Gymraeg a byddwn yn ymateb yn Gymraeg, heb i hynny arwain at oedi.
Correspondence in Welsh is welcomed, and we will respond in Welsh without it leading to a delay.

From:
Sent: 07 July 2023 14:10
To:
Cc:
Subject: RE: Data Request (EIA/Flood risk): Trecelyn Wind Farm

Dear ,

Thank you for your email concerning the above.

Considering your request, please see below:

1. 15-minute rainfall data for gauges within study area, from the earliest record to present. In none within study area please provide data for the closest gauge – Please identify the gauges you require using the following links:

- Data Type (e.g. Rainfall, Level Data, Flow Data, Groundwater) - Rainfall
- Location (Grid Ref or Postcode) - ST 23440 98116, ST 23193 96915 and ST 22902 96117
- Date From – Earliest record
- Date To – Latest record
- Resolution (e.g. 15min/ Day Total/Day Mean etc) – 15m
- Station Name - only if known. Can be found on NRFA website https://nrfa.ceh.ac.uk/ & https://www.gaugemap.co.uk/# or NRW'S RLOI website https://naturalresources.wales/riverlevels?lang=en
  River levels, rainfall and sea levels - Its: https://rivers-and-seas.naturalresources.wales/
  UKCFF tidal data can be downloaded free of charge from this website:
  https://www.bodc.ac.uk/data/hosted_data_systems/sea_level/uk_tide_gauge_network/

2. Licensed surface water and groundwater abstractions within the study area (licence ref, NGR, source, holder, purpose, licensed volume) - excel format – Please see the link which is freely available, on Data Map Wales -
   https://datamap.gov.wales/layers/geonode:nrw_water_resource_permits

3. Groundwater level data (in mAOD) and groundwater quality data for monitoring boreholes within the study area and borehole information (coordinates, aquifer monitored, datum in mAOD). If there are no boreholes within the study area then please provide data for the nearest monitoring borehole - excel format – Please fill in the following and return to us:

- Data Type (e.g. Rainfall, Level Data, Flow Data, Groundwater)
- Location (Grid Ref or Postcode)
- Date From
- Date To
- Resolution (e.g. 15min/ Day Total/Day Mean etc)
- Station Name - only if known. Can be found on NRFA website https://nrfa.ceh.ac.uk/ & https://www.gaugemap.co.uk/# or NRW'S RLOI website https://naturalresources.wales/riverlevels?lang=en
  River levels, rainfall and sea levels - Its: https://rivers-and-seas.naturalresources.wales/
  UKCFF tidal data can be downloaded free of charge from this website:
  https://www.bodc.ac.uk/data/hosted_data_systems/sea_level/uk_tide_gauge_network/

4. Surface water quality data. River and stream quality (chemistry and biological monitoring) data, ideally for within the study area, failing that the nearest available site downstream. Also location data of the sampling points (coordinates, watercourse, sampling point name) - excel format – Please see the following link which is freely available –

https://datamap.gov.wales/layers/geonode:nrw_water_quality_archive_stations for anything you require after 28/02/21, please fill in the information below and return to us:

1. Data Type – Water quality
2. Location -
3. Date From -
4. Date To -
5. Parameters of interest –
6. Site ID – only if known. Water Framework Directive monitoring sites can be found on Water Watch Wales (naturalresourceswales.gov.uk). Select Cycle 3 (2021) Rivers and Waterbodies Map and tick the Surface Water Monitoring Layer to show monitoring sites. Water quality sites are shown in red.

5. Flood modelling products 5, 6 (Model reports and output) associated with the Afon Ebwy and tributaries within the study area – We will advise in due course.

6. Records of historical flooding within the study area – Please see the following link - https://datamap.gov.wales/layers/inspire-nrw:NRW_HISTORIC_FLOODMAP

We look forward to hearing from you in due course.

Yours sincerely,

Enw / **Name**
Teitl swydd / Job title Data Licensing Officer
Adran / Department Customer, Communications and Commercial
Rhif ffôn /
Dyddiau gweithio (os yn berthnasol) / Working days Mon-Fri

Croesewir gohebiaeth yn Gymraeg a byddwn yn ymateb yn Gymraeg, heb i hynny arwain at oedi.
Correspondence in Welsh is welcomed, and we will respond in Welsh without it leading to a delay.

From:
Sent: 07 July 2023 11:59
To: **Cc:**
Subject: Data Request (EIA/Flood risk): Trecelyn Wind Farm

Dear Sir / Madam,

As part of Environmental Impact Assessment and Flood Risk work which WSP UK Limited is undertaking for the planning application for Trecelyn Wind Farm, I would like to make the information requests below. The planning application boundary (red line) is shown on the attached PDF plan, and wider study area (1.5km buffer) shapefile is included for reference. The proposed development includes four wind turbines, substation, temporary construction compound and is split over three parcels of land (Grid Reference ST 23440 98116, ST 23193 96915 and ST 22902 96117) within the Caerphilly County Borough Council administrative area. Please note that the current proposed layout may be subject to change following further surveys and consultation.

1. 15-minute rainfall data for gauges within study area, from the earliest record to present. In none within study area please provide data for the closest gauge
2. Licensed surface water and groundwater abstractions within the study area (licence ref, NGR, source, holder, purpose, licensed volume) - excel format;
3. Groundwater level data (in mAOD) and groundwater quality data for monitoring boreholes within the study area and borehole information (coordinates, aquifer monitored, datum in mAOD). If there are no boreholes within the study area then please provide data for the nearest monitoring borehole - excel format;
4. Surface water quality data. River and stream quality (chemistry and biological monitoring) data, ideally for within the study area, failing that the nearest available site downstream. Also location data of the sampling points (coordinates, watercourse, sampling point name) - excel format;
5. Flood modelling products 5, 6 (Model reports and output) associated with the Afon Ebwy and tributaries within the study area.
6. Records of historical flooding within the study area

Should you need to contact me prior to carrying out any search or if you have any specific query about this request, then please do not hesitate to contact me (or Charlotte Edgeley in my absence).

Kind regards

Associate – Water Management
MEng MSc PhD MCIWM
She/Her
M +44 07866014031
Working hours: Mond/Tuesd 9:00-17:30, Wedn/Thursd/Frid 9:00-15:00

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Annex B
Estimation of Surface Water Runoff Attenuation Volumes

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 28 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.555	0.155	0.1	0.2	0.2	0.7	O K
30 min Summer	99.544	0.144	0.0	0.2	0.2	0.6	O K
60 min Summer	99.527	0.127	0.0	0.2	0.2	0.4	O K
120 min Summer	99.505	0.105	0.0	0.1	0.2	0.3	O K
180 min Summer	99.488	0.088	0.0	0.1	0.2	0.2	O K
240 min Summer	99.475	0.075	0.0	0.1	0.1	0.1	O K
360 min Summer	99.456	0.056	0.0	0.1	0.1	0.1	O K
480 min Summer	99.444	0.044	0.0	0.1	0.1	0.0	O K
600 min Summer	99.435	0.035	0.0	0.1	0.1	0.0	O K
720 min Summer	99.428	0.028	0.0	0.1	0.1	0.0	O K
960 min Summer	99.420	0.020	0.0	0.1	0.1	0.0	O K
1440 min Summer	99.414	0.014	0.0	0.0	0.0	0.0	O K
2160 min Summer	99.411	0.011	0.0	0.0	0.0	0.0	O K
2880 min Summer	99.409	0.009	0.0	0.0	0.0	0.0	O K
4320 min Summer	99.407	0.007	0.0	0.0	0.0	0.0	O K
5760 min Summer	99.407	0.007	0.0	0.0	0.0	0.0	O K
7200 min Summer	99.406	0.006	0.0	0.0	0.0	0.0	O K
8640 min Summer	99.405	0.005	0.0	0.0	0.0	0.0	O K
10080 min Summer	99.405	0.005	0.0	0.0	0.0	0.0	O K
15 min Winter	99.555	0.155	0.1	0.2	0.2	0.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	5.600	0.0	0.9	19
30 min Summer	2.800	0.0	0.9	29
60 min Summer	1.400	0.0	0.9	44
120 min Summer	0.700	0.0	0.9	78
180 min Summer	0.467	0.0	0.9	108
240 min Summer	0.350	0.0	0.9	138
360 min Summer	0.233	0.0	0.9	196
480 min Summer	0.175	0.0	0.9	254
600 min Summer	0.140	0.0	0.9	312
720 min Summer	0.117	0.0	0.9	372
960 min Summer	0.088	0.0	0.9	490
1440 min Summer	0.058	0.0	0.9	724
2160 min Summer	0.039	0.0	0.9	1100
2880 min Summer	0.029	0.0	0.9	1420
4320 min Summer	0.019	0.0	0.9	2140
5760 min Summer	0.015	0.0	0.9	2920
7200 min Summer	0.012	0.0	0.9	3544
8640 min Summer	0.010	0.0	0.9	4280
10080 min Summer	0.008	0.0	0.9	5120
15 min Winter	5.600	0.0	0.9	19

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	99.544	0.144	0.0	0.2	0.2	0.6	O K
60 min Winter	99.525	0.125	0.0	0.2	0.2	0.4	O K
120 min Winter	99.497	0.097	0.0	0.1	0.2	0.2	O K
180 min Winter	99.476	0.076	0.0	0.1	0.1	0.1	O K
240 min Winter	99.460	0.060	0.0	0.1	0.1	0.1	O K
360 min Winter	99.440	0.040	0.0	0.1	0.1	0.0	O K
480 min Winter	99.428	0.028	0.0	0.1	0.1	0.0	O K
600 min Winter	99.421	0.021	0.0	0.1	0.1	0.0	O K
720 min Winter	99.417	0.017	0.0	0.1	0.1	0.0	O K
960 min Winter	99.414	0.014	0.0	0.0	0.0	0.0	O K
1440 min Winter	99.411	0.011	0.0	0.0	0.0	0.0	O K
2160 min Winter	99.409	0.009	0.0	0.0	0.0	0.0	O K
2880 min Winter	99.407	0.007	0.0	0.0	0.0	0.0	O K
4320 min Winter	99.406	0.006	0.0	0.0	0.0	0.0	O K
5760 min Winter	99.405	0.005	0.0	0.0	0.0	0.0	O K
7200 min Winter	99.405	0.005	0.0	0.0	0.0	0.0	O K
8640 min Winter	99.404	0.004	0.0	0.0	0.0	0.0	O K
10080 min Winter	99.404	0.004	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	2.800	0.0	0.9	30
60 min Winter	1.400	0.0	0.9	48
120 min Winter	0.700	0.0	0.9	80
180 min Winter	0.467	0.0	0.9	112
240 min Winter	0.350	0.0	0.9	140
360 min Winter	0.233	0.0	0.9	196
480 min Winter	0.175	0.0	0.9	254
600 min Winter	0.140	0.0	0.9	310
720 min Winter	0.117	0.0	0.9	372
960 min Winter	0.087	0.0	0.9	482
1440 min Winter	0.058	0.0	0.9	700
2160 min Winter	0.039	0.0	0.9	1088
2880 min Winter	0.029	0.0	0.9	1376
4320 min Winter	0.019	0.0	0.9	2108
5760 min Winter	0.015	0.0	0.9	2744
7200 min Winter	0.012	0.0	0.9	3392
8640 min Winter	0.010	0.0	0.9	4312
10080 min Winter	0.008	0.0	0.9	4936

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 323350 198150 ST 23350 98150
C (1km)	0.000
D1 (1km)	0.000
D2 (1km)	0.000
D3 (1km)	0.000
E (1km)	0.000
F (1km)	0.000
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	1.000
Cv (Winter)	1.000
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.062

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.031	4	8	0.031

Model Details

Storage is Online Cover Level (m) 100.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.03600	Length (m)	100.0
Infiltration Coefficient Side (m/hr)	0.03600	Side Slope (1:X)	1.5
Safety Factor	2.0	Slope (1:X)	75.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	99.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.6		

Orifice Outflow Control

Diameter (m) 0.012 Discharge Coefficient 0.950 Invert Level (m) 99.400

Summary of Results for 20 year Return Period (+20%)

Half Drain Time : 137 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	99.751	0.051	5.0	19.8	O K
30 min Summer	99.767	0.067	5.0	31.4	O K
60 min Summer	99.783	0.083	5.0	43.7	O K
120 min Summer	99.799	0.099	5.0	55.8	O K
180 min Summer	99.808	0.108	5.0	62.6	O K
240 min Summer	99.814	0.114	5.0	66.7	O K
360 min Summer	99.819	0.119	5.0	70.5	O K
480 min Summer	99.819	0.119	5.0	70.5	O K
600 min Summer	99.817	0.117	5.0	68.9	O K
720 min Summer	99.813	0.113	5.0	66.2	O K
960 min Summer	99.805	0.105	5.0	59.7	O K
1440 min Summer	99.787	0.087	5.0	46.2	O K
2160 min Summer	99.766	0.066	5.0	30.6	O K
2880 min Summer	99.754	0.054	5.0	21.5	O K
4320 min Summer	99.746	0.046	4.3	16.1	O K
5760 min Summer	99.743	0.043	3.7	13.7	O K
7200 min Summer	99.740	0.040	3.2	12.2	O K
8640 min Summer	99.739	0.039	3.0	11.1	O K
10080 min Summer	99.737	0.037	2.8	10.3	O K
15 min Winter	99.757	0.057	5.0	23.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	74.572	0.0	20
30 min Summer	52.593	0.0	34
60 min Summer	35.684	0.0	62
120 min Summer	23.908	0.0	106
180 min Summer	18.866	0.0	140
240 min Summer	15.899	0.0	176
360 min Summer	12.394	0.0	246
480 min Summer	10.299	0.0	316
600 min Summer	8.880	0.0	386
720 min Summer	7.845	0.0	454
960 min Summer	6.417	0.0	584
1440 min Summer	4.800	0.0	838
2160 min Summer	3.587	0.0	1188
2880 min Summer	2.932	0.0	1504
4320 min Summer	2.244	0.0	2208
5760 min Summer	1.881	0.0	2936
7200 min Summer	1.662	0.0	3672
8640 min Summer	1.514	0.0	4400
10080 min Summer	1.407	0.0	5136
15 min Winter	74.572	0.0	20

Summary of Results for 20 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	99.774	0.074	5.0	37.1	O K
60 min Winter	99.793	0.093	5.0	51.3	O K
120 min Winter	99.812	0.112	5.0	65.3	O K
180 min Winter	99.821	0.121	5.0	72.1	O K
240 min Winter	99.827	0.127	5.0	76.4	O K
360 min Winter	99.831	0.131	5.0	79.4	O K
480 min Winter	99.829	0.129	5.0	77.9	O K
600 min Winter	99.824	0.124	5.0	74.3	O K
720 min Winter	99.818	0.118	5.0	69.5	O K
960 min Winter	99.803	0.103	5.0	58.5	O K
1440 min Winter	99.775	0.075	5.0	37.6	O K
2160 min Winter	99.750	0.050	5.0	19.0	O K
2880 min Winter	99.746	0.046	4.2	15.5	O K
4320 min Winter	99.740	0.040	3.2	12.0	O K
5760 min Winter	99.737	0.037	2.7	10.0	O K
7200 min Winter	99.734	0.034	2.3	8.8	O K
8640 min Winter	99.733	0.033	2.1	7.9	O K
10080 min Winter	99.732	0.032	2.0	7.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	52.593	0.0	34
60 min Winter	35.684	0.0	62
120 min Winter	23.908	0.0	116
180 min Winter	18.866	0.0	150
240 min Winter	15.899	0.0	190
360 min Winter	12.394	0.0	268
480 min Winter	10.299	0.0	344
600 min Winter	8.880	0.0	420
720 min Winter	7.845	0.0	490
960 min Winter	6.417	0.0	626
1440 min Winter	4.800	0.0	868
2160 min Winter	3.587	0.0	1148
2880 min Winter	2.932	0.0	1476
4320 min Winter	2.244	0.0	2224
5760 min Winter	1.881	0.0	2896
7200 min Winter	1.662	0.0	3680
8640 min Winter	1.514	0.0	4400
10080 min Winter	1.407	0.0	5216

Rainfall Details

Rainfall Model	FEH
Return Period (years)	20
FEH Rainfall Version	2013
Site Location	GB 323350 198150 ST 23350 98150
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.250

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.125	4	8	0.125

Model Details

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.03600	Width (m)	50.0
Membrane Percolation (mm/hr)	1000	Length (m)	50.0
Max Percolation (l/s)	694.4	Slope (1:X)	1000.0
Safety Factor	5.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.700	Membrane Depth (m)	0

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