Chapter 10

Hydrology, Geology and Hydrogeology

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Glossary

Term	Definition
Abstraction	The process of and location of the removal or diversion of water from the natural water environment, by a variety of means including pumps, pipes, boreholes and wells.
Aquifer	A geological formation, group of formations or part of a formation that can store and transmit water in significant quantities.
Acrotelm	One of two distinct layers in undisturbed peat bogs. It overlies the catotelm.
Baseflow	The component of the river flow that is derived from groundwater sources rather than surface run-off. The Base Flow Index (BFI) value provided by the Flood Estimation Handbook (FEH) is a measure of the proportion of a catchments long-term runoff that derives from stored sources.
Buffer area	An area which protects the receptor such as watercourses from pollutants and sediment from the adjacent land.
Catotelm	The lower, water-saturated zone of a mire/peat bog.
Environmental Impact Assessment	Environmental Impact Assessment (EIA) is a means of carrying out, in a systematic way, an assessment of the likely significant environmental affects arising from a proposed development.
Groundwater	Water located beneath the ground surface in soil pore spaces and in the fractures of rock formations.
Headwaters	A tributary stream of a river close to or forming part of its source. Normally wet flushes, bogs or springs at the head of first-order streams.
Hydrological regime	The statistical pattern of a river's constantly varying flow rate.
Hydromorphology	Term used in river basin management to describe the hydrological and geomorphological processes and attributes of rivers, lakes, estuaries and coastal waters.
North section	Section of development located north of Bryn settlement, within Penhydd forestry block.
Overland flow	Water passing rapidly over or through the surface layer of soil.
Peak flow	The maximum flow recorded during a high flow event.
Peat	A largely organic substrate formed of partially decomposed plant material.
Precipitation	Deposition of moisture including dew, hail, rain, sleet and snow.
Private water supply	Any water supply which is not provided by a water company and is not connected to mains supply. Most private water supplies are situated in more remote, rural parts of the country and may just serve one property or several properties through a network of pipes.
Return period	Is a measure of the rarity of an event: the longer the return period, the rarer the event.
Riparian zone	Land immediately adjoining the aquatic zone of a watercourse and influenced by it.
Runoff	Surface runoff is the flow of water over the surface that can result due to the surrounding soils lacking the capacity to infiltrate further water or due to the surface water flowing off infrastructure such as access tracks and hardstandings.
Sedimentation	The tendency for particles in suspension to settle out of the fluid in which they are entrained.
Site boundary	The area within which the proposed development will be located.
South section	Section of development located south of Bryn settlement, within Bryn forestry block.
Standard Percentage Runoff	The percentage of rainfall that is likely to contribute to runoff. For example, an SPR value of 50 % would suggest that half of the rainfall during an event will contribute to runoff.
Surface water catchment	The area from which runoff would naturally discharge to a defined point of a river.
Topography	The physical features of a geographical area.
Water resources	The supply of groundwater and surface water in a given area.
Wind farm site boundary	The area that the wind farm lies within (includes the north and south section of forestry).

List of Abbreviations

Abbreviation	Description
AOD	Above Ordnance Datum
BCBC	Bridgend County Borough Council
BFI	Base Flow Index
BGS	British Geological Society
CEMP	Construction Environmental Management Plan
CIRIA	Construction Industry Research and Information Association
DOC	Dissolved Organic Carbon
DTM	Digital Terrain Model
ECoW	Environmental Clerk of Works
EIA	Environmental Impact Assessment
FEH	Flood Estimation Handbook
GPP	Guidance for Pollution Prevention
HMP	Habitat Management Plan
LNR	Local Nature Reserve
NFM	Natural Flood Management
NRW	Natural Resource Wales
PEDW	Planning and Environment Decisions Wales
PMP	Peat Management Plan
PPG	Pollution Prevention Guidelines
PWS	Private Water Supply
PWSMP	Private Water Supply Monitoring Plan and Method Statement
RBMP	River Basin Management Plans
SAAR	Standard Average Annual Rainfall
SAB	SuDS Approval Body
SEPA	Scottish Environment Protection Agency
SPR	Standard Percentage Runoff
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
TWI	Topographic Wetness Index
UKSO	UK Soil Observatory
WFD	Water Framework Directive

10.1 INTRODUCTION

10.1.1 This chapter provides an assessment of potential impacts on the hydrological, geological and hydrogeological environment at Y Bryn Wind Farm (the proposed development) and the likely significant environmental effects resulting from the construction, operation and decommissioning of the proposed turbines and associated infrastructure. The red-line boundary is referred to as 'Y Bryn Site Boundary' which includes the main wind farm and proposed access routes.

10.1.2 The chapter concludes that with good practice design and construction of the proposed development delivered through a skilled team of competent workers, with mitigation and compliance monitored in collaboration with Natural Resources Wales (NRW), Neath Port Talbot County Borough Council (NPTCBC), Bridgend County Borough Council (BCBC) and other engaged stakeholders, will result in a risk that is considered to be **not significant** in the professional judgment of Natural Power.

10.1.3 As part of the development process Sustainable Drainage Systems (SuDs) are required which will comply with National Statutory SuDs Standards. An application will be submitted to the SuDs Approval Body (SAB) prior to construction commencing. NPTCBC and BCBC are the SAB for the proposed development.

Site Area

10.1.4 Y Bryn Wind Farm (the proposed development) is located in both NPT area and BCBC area, South Wales. It is comprised of two forestry areas (the Bryn forestry section to the south of the B4282 in the Margam Forest area, and the Penhydd forestry section to the north in the vicinity of Bryn and Maesteg settlements) referred to as the 'north section' and 'south section' respectively hereafter, where the turbines and associated infrastructure are proposed. The proposed development also consists of a new access route from the M4 and upgrade of track linking the north section to the south section of the development (link road).

10.1.5 The hydrological study area is larger in extent than the actual Y Bryn Site Boundary (including access and link road) and includes the upper and lower reaches of watercourse catchments that are present within Y Bryn Site Boundary. The extent of the catchments is shown in Figure 10.1 Hydrology Overview which outlines the extent of the study area. Designated sites and relevant developments are considered from the perspective of assessing any potential hydrological linkages or cumulative effects.

10.2 LEGISLATION, POLICY AND NATIONAL GUIDANCE

International Legislation and Policy

10.2.1 The assessment takes into account the requirements of the Water Framework Directive (2000/60/EC) (WFD). The WFD aims to protect and enhance the quality of surface freshwater (including lakes, rivers and streams), groundwater, groundwater dependent ecosystems, estuaries and coastal waters. The key objectives of the WFD relevant to this assessment are:

- To prevent deterioration and enhance aquatic ecosystems; and
- To establish a framework of protection of surface freshwater and groundwater.

National Legislation and Regulations

10.2.2 This assessment takes into account the following legislation and policy:

- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017;
- Land Drainage Act 1994;
- Flood and Water Management Act 2010;
- Water Act 2014;
- The Pollution Prevention and Control (England and Wales) Regulations 2000;
- The Water Supply (Water Quality) Regulations 2018;
- The Private Water Supplies (Wales) Regulations 2017;
- The Waste (England and Wales) (Amendment) Regulations 2012;
- Part IIa of the Environment Protection Act 1990;
- The Town and Country Planning Environmental Impact Assessment (EIA) Regulations 2017;
- Well-being of Future Generations (Wales) Act 2015;
- The Environmental Permitting (England and Wales) Regulations 2016; and
- Water Resources Act 1991.

Policy and Guidance

10.2.3 The following Welsh guidance and regional policies are also taken into account during the assessment:

- Planning Policy Wales (Edition 11) – February 2021;
- Future Wales: The National Plan 2040 (2021);
- Technical Advice Note 15: Development and Flood Risk (2004);
- Statutory standards for sustainable drainage systems (2018);
- Sustainable Drainage (SuDS) Statutory Guidance (2019);
- Neath Port Talbot County Borough Council Local Development Plan (2011 – 2026) - (adopted 2016); and
- Bridgend County Borough Council Local Development Plan (2006 - 2021) and replacement LDP (currently out for consultation).

10.2.4 Table 10.1 lists other guidance and good practice documentation which has been considered as part of this assessment.

Table 10.1: Guidance and Good Practice

Topic	Source of Information
Natural Resource Wales (NRW) Guidance for Pollution Prevention (GPP) & Pollution Prevention Guidelines (PPG's) *	GPP 1: Understanding your environmental responsibilities - good environmental practices. GPP 2: Above ground oil storage tanks GPP 4: Treatment and disposal of wastewater where there is no connection to the public foul sewer. GPP 5: Works and maintenance in or near water PPG 6: Working at construction and demolition sites. GPP 8: Safe storage and disposal of used oil GPP 13: Vehicle washing and cleaning. GPP 21: Polluting incident response planning GPP 22: Dealing with spills. GPP 26: Safe Storage - drums and intermediate bulk containers
Construction Industry Research and Information Association (CIRIA)	CIRIA C692 Environmental Good Practice on site (third edition) CIRIA C697 SuDS Manual CIRIA C532 Control of Water Pollution from Construction sites

Topic	Source of Information
	CIRIA C624 Development and Flood Risk – guidance for the construction industry CIRIA C648 Control of Water Pollution from Linear Construction Projects CIRIA C689 Culvert Design and Operation Guide CIRIA C758D Abandoned Mine Workings Manual
Other Guidelines	Environment Agency, The Environment Agency's approach to groundwater protection (2018) Scottish Renewables Joint Publication, (2019) Good Practice During Wind Farm Construction Version 4 Forestry Civil Engineering, Scottish Natural Heritage, (2010), Floating Roads on Peat Scottish Renewables, Joint Publication (2012), Development of Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste DEFRA (2009) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Scottish Environment Protection Agency (SEPA) Land Use Planning Guidance Note 31 (2017). Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems, Version 3

*A review plan for the PPGs is currently underway. The review will result in a replacement guidance series, Guidance for Pollution Prevention (GPPs). It is intended that the new series will provide environmental good practice guidance for the whole UK, and environmental regulatory guidance directly to Northern Ireland, Scotland and Wales.[1]

10.3 METHOD OF ASSESSMENT

Effects to be Assessed

10.3.1 The greatest risk of affecting the hydrological, geological and hydrogeological environment will occur during the construction phase, with the potential for effects reduced during the operational and decommissioning phases. Taking this into account the EIA addresses the following issues for all phases of development:

- Changes to existing drainage patterns;
- Effects on baseflow;
- Effects on run-off rates;
- Effects on erosion and sedimentation;
- Effects on groundwater levels;
- Effects on water resources;
- Effects on impediments to flow;
- Flood risk;
- Pollution risk;
- Effects on integrity of peat bodies;
- Effects on groundwater and surface water quality; and
- Effects on the hydrological and hydrogeological environment arising from previous mineral working.

Methodology

Overview

10.3.2 The assessment has involved the following:

- Detailed desk studies and site visits to establish baseline conditions of the area and carry out detailed site investigations;
- Evaluation of the likely significant environmental effects of the proposed development and the impacts that these could have on the current site conditions;
- Demonstration of how the embedded good practice measures help to avoid and mitigate against any identified adverse effects resulting from the proposed development;
- Evaluation of the likely significant environmental effects with consideration of the potential embedded mitigation measures, taking account of the sensitivity of the baseline features, the potential magnitude of these impacts and the probability of these effects occurring; and
- The residual significance of the environmental effects following the consideration of additional mitigation measures, as well as further potential enhancement measures.

Baseline Assessment

10.3.3 A desktop survey to establish the baseline conditions was undertaken in order to:

- Describe surface water hydrology, including watercourses, springs and waterbodies;
- Identify existing catchment pressures (e.g., point source and diffuse pollution issues);
- Identify all private drinking water abstractions and public water supplies within 3 km of the proposed development;
- Identify all flooding risks;
- Describe the hydromorphological conditions of watercourses;
- Collect information relating to recreational and fisheries resources;
- Collect soil, geological and hydrogeological information;
- Collect information relating to previous mineral working;
- Confirm surface water catchment areas and watersheds; and
- Confirm the extent and nature of any peat deposits across the site of the proposed development.

10.3.4 Published information sources consulted for the baseline information are outlined in Table 13.2 of the scoping report[2] (scoping report can be found in Appendix 3.1 in Volume 3 of this ES).

Effects Evaluation

10.3.5 The likely significant environmental effects are defined by taking account of two main factors: the sensitivity of the receptor and the potential magnitude should that effect occur. The sensitivity of the receptor i.e., its baseline quality as well as its ability to absorb the effect without perceptible change is defined in Table 10.2.

[1] Net Regs (2020). *Guidance for Pollution Prevention (GPPs) - Full List*. [Online]. Available from: http://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/ [Accessed: 05/08/2022]

[2] Y Bryn Wind Farm (2021) *Scoping Report* (Document Reference: 1233647)

Table 10.2: Definition of sensitivity of the receptor

Sensitivity	Definition
High	**National importance**. Receptor with a high quality and rarity, local scale and limited potential for substitution/replacement or receptor with a medium quality and rarity, regional or national scale and limited potential for substitution / replacement.
Medium	**Regional importance**. Receptor with a medium quality and rarity, local scale and limited potential for substitution/replacement or receptor with a low quality and rarity, regional or national scale and limited potential for substitution / replacement.
Low	**Local importance**. Receptor with a low quality and rarity, local scale. Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character.

10.3.6 The magnitude of impact includes the timing, scale, size and duration of the likely significant environmental effects. For the EIA the magnitude of impact criteria is defined in Table 10.3.

Table 10.3: Magnitude of Impact

Magnitude	Criteria	Definition
High	**Total loss** of or major/substantial alteration to key elements/features of the baseline (pre-development) conditions such that the post development character/composition/attributes will be fundamentally changed.	Fundamental (long term or permanent) changes to geology, hydrology, water quality and hydrogeology.
Medium	**Loss or alteration** to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of the baseline will be materially changed.	Material but non-fundamental and short to medium term changes to the geology, hydrology, water quality and hydrogeology.
Low	**A minor shift** away from baseline conditions. Change arising from the loss/alteration will be discernible/detectable but not material. The underlying character/composition/attributes of the baseline condition will be similar to the pre-development circumstances/situation.	Detectable but non-material and transitory changes to the geology, hydrology, water quality and hydrogeology.
Negligible	**Very little change** from baseline conditions. Change barely distinguishable, approximating to a 'no change' situation.	No perceptible changes to the geology, hydrology, water quality and hydrogeology.

10.3.7 The sensitivity of the receiving environment together with the magnitude of the impact (assuming the successful implementation of industry good practice and design mitigation measures) is then combined to define the significance of the effect, as per Table 10.4. Those residual adverse effects indicated as **Major, and Major/Moderate** will be regarded as being **significant** effects. However, other factors may have to be considered including the duration and the reversibility of the effect. It should also be noted that in most cases the assessment considers only the adverse effects. Where positive effects are identified these will be also be discussed.

Table 10.4: Significance of Effect

		Magnitude of Change			
		High	**Medium**	**Low**	**Negligible**
Sensitivity	**High**	**Major**	**Major/Moderate**	Moderate	Moderate/Minor
	Medium	**Major/Moderate**	Moderate	Moderate/Minor	Minor
	Low	Moderate	Moderate/Minor	Minor	Minor/Negligible

10.4 CONSULTATION

10.4.1 The scoping and consultation responses relating to the hydrological, geological and hydrogeological environment are summarised in Table 10.5.

Table 10.5: List of consultee responses

Consultee	Consultation Response	Applicant Action
The Planning Inspectorate Wales (now Planning and Environment Decisions Wales (PEDW))	Include details to show that the proposed development will not prevent the achievement of Water Framework Directive (WFD) objectives.	Refer to Table 10.16 and Table 10.17 which show the predicted significance of effect of the proposed development. Embedded mitigation will help to prevent deterioration of the water environment.
	A survey should be undertaken to map all water features present on site.	Figure 10.1: Hydrology Overview presents all of the identified hydrological receptors (including abstractions) and associated buffer distances.
	Eglwys Nunydd Reservoir Site of Special Scientific Interest (SSSI) and Bryn Tip Local Nature Reserve (LNR) cannot be scoped out for the reason that their designations are not for hydrology. Designated features may be susceptible to hydrological changes and this potential impacts to the two designated sites need to be considered in the ES.	Following request, hydrological receptors related to designated features are characterised in Section 10.5: Designated Sites. Any required mitigation and monitoring are proposed in Section 10.7: Mitigation Methods.
	A coal mining risk assessment should be provided as part of the ES	Refer to Appendix 10.2: Coal Mining Risk Assessment in Volume 3 of the ES.
NPTCBC	Restoration of all deep peat resources on site to functioning peat bog habitat is recommended.	The final layout was carefully designed to avoid deep peat, therefore minimal peat restoration opportunities were identified. Other environmental proposals have been proposed and are discussed in Appendix 6.3: Outline Habitat Management Plan.
	Unified Peat Map of Wales should be interrogated and used to inform the assessment.	Unified Peat Map of Wales is referenced in Section 10.5 Soils and Peat with data used to inform peat survey assessment.
	Assessment of the hydrological connectivity and function of peat soils, especially deep peat resources should be undertaken.	Section 10.5: Soils and Peat and Figure 10.4: Peat Interpolation provide evidence of surveys undertaken and assessment on the peat soils, and infrastructure has not been located on deep peat.
	Reliance on Scottish Guidance should be avoided. Welsh peat bodies not comparable to deep peat bodies found in Scotland.	Scottish Guidance has been referenced where it has been adopted industry wide as good practice where there is no Welsh equivalent.
	All deep peat resources should be avoided as part of the design and siting of infrastructure. The design should also avoid impact on hydrological connectivity of peat bogs.	Section 10.5: Peat Survey Results provides information on peat and soils underlying the proposed development. No infrastructure as part of the proposed development is located on peat bogs. Figure 10.4: Peat Interpolation illustrates how infrastructure is positioned to avoid deeper soils and peat.
	Cumulative effects should be adequately assessed.	Cumulative effects are presented in Section10.10 Cumulative Effects.
	Advice given as SAB for the SuDS application and approval process	An application will be made to NPTCBC and BCBC as the SAB for SuDS approval
BCBC	There are a number of coal mining legacy issues which should be considered as part of the Environmental Statement.	Refer to Appendix 10.2: Coal Mining Risk Assessment and Section 10.5: Water Quality.
NRW	Any works should not result in contamination of or effect water resources.	Details of embedded mitigation and outline Construction Environmental Management Plan (CEMP) content are provided in Section 10.7: Mitigation.
	A water feature survey should be carried out which identifies all water features which could be affected by proposed operations. NRW outline the steps to carry out the survey. A full impact assessment should be made based on the results of the survey.	Figure 10.1: Hydrology Overview presents all of the identified hydrological receptors (including abstractions) and associated buffer distances. Hydrological receptors are characterised in Section 10.5: Baseline.
	The water features should be assessed to identify any mitigation measures required.	Hydrological receptors are characterised in Section 10.6: Receptor Sensitivity. Any required mitigation is proposed in Section 10.7: Mitigation Methods.
	If dewatering of excavations is required, an abstraction licence might be needed.	Scoped out of the EIA. It would be determined if this is a requirement post consent as part of the detailed design and applied for if required.
	Welcome a CEMP and NRW provide guidance on the content within the scoping response. The CEMP should address pollution prevention and control measures.	Details of outline CEMP content are provided in Section 10.7: Mitigation Methods.
	There should be a dedicated resource during construction to oversee that the CEMP is implemented correctly, and that mitigation is sufficient particularly after prolonged heavy rainfall.	An Environmental Clerk of Works (ECoW) would be appointed prior to construction. ECoW remit would include overseeing compliance with the CEMP and other environmental documentation.

Consultee	Consultation Response	Applicant Action
	Pollution prevention measures should be installed in advance of construction.	Mitigation and monitoring proposals are outlined in Sections 10.7 and 10.11 and will be supplemented by detailed design post consent.
	Advise that to protect access tracks vehicles such as articulated dump trucks ADTs are used as little as possible, and that they are not used after heavy prolonged rainfall.	This advice will be incorporated into the detailed CEMP which would be agreed and produced post consent.
	A soil management plan should be produced. This should be carried out following best practice guidance and include stripping, conservation and storage.	Outline soil handling and management is provided in Section 10.5: Soils and Peat. Further detail would be provided in the detailed CEMP.
	Baseline information on abstractions should be sought from NRW.	Abstraction data has been sourced by local planning authorities.
	Fish habitat design should be incorporated into culvert installation and upgrade plans.	Watercourse crossing designs are discussed in Appendix 10.1 and will be designed to allow safe passage of fish and otter where required.
	Infrastructure assessment should include the cable route and water stops should be considered.	Detailed design of the cable route including placement of water stops and other mitigation if required, will be carried out post consent.
	Risk to controlled waters from historic mining should be considered.	Effects of mining on water quality is discussed in sub section 'Effects of Coal Mining'
	Dŵr Cymru owned reservoir in 'Bryn' block.	Cwmwernderi Reservoir is discussed in Sections 10.5 and 10.6, with outline mitigation summarised in Section 10.7.
	Welcome 50 m buffer but require clarification on proposed buffer zone for unmapped watercourses.	There are limited drainage channels associated with forestry operations sporadically found in the north and south section. Where required mitigation outlined in Section 10.7: Mitigation Methods will be followed to protect site hydrology.
	Welcome further detail on cement and concrete handling in and around watercourses.	Details concerning cement and concrete handling are provided in paragraph 10.7.31 - 10.7.32 Concrete Works.
	A water monitoring / inspection plan will be required covering watercourses and any discharges from treated surface water areas.	Monitoring proposals are presented in Section 10.11: Monitoring.
	Training to include impacts of pollutants on watercourses.	The ECoW would provide toolbox talks on pollution prevention prior to construction commencing and as required thereafter.
	Due consideration must be given to the WFD and a section on WFD should be incorporated into the EIA. NRW outline what this section should include.	Refer to Section 10.5: Water Quality, paragraph 10.5.28
	All watercourses within site boundary are ordinary and culverts/crossing require consent from the Lead Local Flood Authority.	Watercourse crossing designs are discussed in Appendix 10.1.
	A small section of the Nant Cwmwernderi is located within flood zone C2 of the Development Advice Map (DAM). Any work within 8m might require a Floor Risk Activity Permit (FRAP).	There is no infrastructure within 8 m of tributaries to the Nant Cwmwernderi and no infrastructure within approximately 370 m of the reservoir. This is illustrated on Figure 10.1: Hydrology Overview. This requirement can therefore be scoped out.
	Advise a Preliminary Risk Assessment (PRA) for contaminated land is carried out.	Refer to Appendix 10.2: Coal Mining Risk Assessment which recommends that should planning permission be granted for the project, a more detailed desk study is carried out, including development of a geo-environmental conceptual model which would encompass the requirement for a PRA for contaminated land.
	Probing to determine peat depth should be calibrated periodically by hand augering to determine presence of peat.	Details of peat probing methodology are presented in Section 10.5: Soils and Peat.
	NRW outline how peat data should be presented.	Peat data is presented in Figure 10.4: Peat Interpolation taking into consideration NRW requirements. Method of interpolation is included on the figure. Raw peat data can be provided on request
	NRW outline peat probing method including if deep peat is encountered to probe every 20m until it is no longer encounter (<30cm) to accurately determine extend/edge of peat body.	Details of peat probing methodology presented in Section 10.5.: Soils and Peat.

Consultee	Consultation Response	Applicant Action
	Within peatland habitats probing will nominally be conducted on a 10m grid with a peat core 1 in every 10 peat probes.	Details of peat probing methodology presented in Section 10.5: Soils and Peat.
	Peat Management Plan (PMP) should include contingency plans in the event more peat is encountered than predicted.	Based on the results of the peat depth surveys and as discussed in Section 10.5: Soils and Peat a PMP for the proposed development has been scoped out.
	EIA needs to demonstrate that impacts on peat through the peat surveys have been avoided and minimised. Sufficient peat data should be collected to demonstrate overall peat distribution across the application site.	Figure 10.4: Peat Interpolation illustrates infrastructure location in relation to peat and soil depth. The proposed development has been designed to be located on peaty soils rather than peat. Survey results verified through soil coring as discussed in Section 10.5: Soils and Peat.
NRW Pre-App (20 October 2022)	Consider that the effects associated with the operational and decommissioning phases of the wind farm are considered as part of the ES	It is confirmed that these phases are considered within the chapter
	Rainfall data is out of date	The rainfall chart has been updated using the most recent data
	All runoff to be adequately treated via a suitably designed drainage scheme with appropriate sediment and pollution management measures. More detail will be required on planned water treatment prior to construction	Further details would be provided during the application to the SAB for SuDS approval. Detailed design would be carried out post consent including drainage design and appropriate sediment and pollution mitigation measures would be an integral part of the design.
	It is unclear what the intended method for sewerage will be for welfare facilities. The report refers to tinkering away. An environmental permit may be required if discharging to ground/surface water	This would be confirmed by the Contractor and appropriate environmental permit sought if required.
	Outline concerns regarding reference to the materials to be used during construction of the proposed development and the problem of these materials tending to break down easily. Recommend reviewing options for sourcing aggregate for use should material sourced on site overwhelm implemented pollution prevention methods.	This would be considered fully post consent and appropriate material used.
	NRW will not approve the use of flocculant until all other measures have been pursued and exhausted and it is likely to require an environmental permit.	This will be incorporated into the CEMP or Pollution Prevention Plan.
	Advise liaising with NPTCBC regarding Natural Flood Management	NPTCBC would be consulted at the appropriate time
	Recommend that the sensitivity of the Llynfi River is upgraded given the existing fish populations in this river.	This has been upgraded in the assessment of construction and operational effects.
	If the area is ‘clay heavy’ extra time might be required for settling. If flocculant is necessary a permit may be required.	This will be incorporated into the detailed design, CEMP and / or Pollution Prevention Plan
	There are no details on the disposal of concrete wash water and other waste concrete, NRW would welcome clarification	This detail would be provided by the Contractor and included in the appropriate document such as the CEMP.
	There should be no direct discharge to groundwater, water should be infiltrating as part of the SUDS regime.	This would be incorporated into the detailed design post consent.
	Welcome that watercourse crossings have been minimised but recommend that something more resilient to future flow increases such as a bottomless arch is considered.	Watercourse crossings both, new and upgraded will be designed for a 1 in 200 year + Climate Change flood event. Ecological provisions such as fish and mammal passage would be considered.
	Welcome commitment to produce a detailed CEMP and recommend consulting with NPT Environment Team to agree content.	Confirm NPTCBC will be consulted to agree the content of the CEMP.
	Discharging of water to land must be carefully planned and monitored and as such should form part of the CEMP.	A monitoring programme will be included as part of the CEMP
	Risks from cable trenching and laying should be assessed.	Included as part of pre-construction works and mitigated in the CEMP.
	Modifications of groundwater flows and levels can occur as a result of cut tracks and their drainage and turbine foundations and hardstands, potentially impacting peatland environments and mitigation, restoration and enhancement isn’t documented in any detail	The proposed development has been designed to avoid peatlands. Tracks will be designed to allow water throughflow. Restoration and enhancement would be detailed in the HMP.

Consultee	Consultation Response	Applicant Action
	Recommend baseline groundwater investigations/monitoring is undertaken to understand the groundwater regime	This requirement can be agreed post consent.
	Consideration should be given to potential cumulative effects throughout construction and operational phases	Considered in Section 10.10 Cumulative Effects.
	Water monitoring control sites would need to be areas unaffected by pollution	
	Limited to no superficial cover and the bedrock geology consists of Brithdir member sandstone and is a Secondary A aquifer. The site has medium groundwater vulnerability. There are PWS and licensed groundwater abstraction within 2-3 km of the site that may need consideration.	Further consideration would be given as part of the further assessments post consent.
	Groundwater could be vulnerable to pollution and groundwater flows and levels could be at risk. Recommend that a water feature survey is undertaken. The response outlines what is to be included in the survey,	The shallow nature of the foundations means that there is unlikely to be an effect on groundwater flows and levels. This would be assessed as required post consent.
	Groundwater features may require monitoring during the proposed works	This would be included in the water monitored programme as required.
	Borrow pits and the risks they pose require further consideration	This would be included in a borrow pit appraisal as part of the CEMP/
	Specific permissions are sometimes required to drill within coal mine areas	These permissions would be sought.

10.5 BASELINE

Field Survey Techniques

10.5.1 Hydrology walkover surveys and peat surveys were undertaken by Natural Power at the Y Bryn Wind Farm to inform the baseline. The hydrology surveys comprised of a walkover survey, undertaken on foot by a hydrologist, where watercourses and other hydrological features were inspected to establish their morphology and morphometry. Peat surveys included the collection of thickness values by advancing “peat probes” through to the underlying substrate. In addition to these, peat cores collected by a hand auger were also undertaken at strategic locations along with hand shear vanes. More information of peat surveys is presented in Section 10.5: Peat Survey Results.

10.5.2 The phase 1 peat depth survey and hydrological walkover were undertaken during February 2021. Weather conditions were dry and sunny at the beginning of the week before getting progressively wetter.

10.5.3 The phase 2 peat survey and further hydrological surveys were undertaken in October and November 2021 and January, March and April 2022. Weather conditions were dry during the October surveying, with rain showers during the November surveying. Sunny and dry weather conditions were encountered during the January, March and April 2022 site visits.

10.5.4 Site surveys were also undertaken in April 2021 as part of the CMRA with further details included in Appendix 10.2.

Future Baseline

10.5.5 Without the proposed development, it is likely that the site would continue to be used for productive forestry. The recorded baseline scenario for the hydrological, geological and hydrogeological area of the proposed development has the potential to change due to climate change scenarios. This includes, but is not limited to:

- An increase in intense rainfall events that have the potential to increase the risk of flooding to receptors downstream of the proposed development; and
- Prolonged periods of drier, warmer weather reducing the availability of water supplying private water supplies (PWS) as well as reducing water flows in watercourses.

10.5.6 The adoption of permanent drainage as part of the proposed development will also seek to mitigate pressures on the water environment through the incorporation of sustainable design features as well as impacts of peatland habitat improvement which will have been proven to attenuate peak flows and improve water quality.

Context

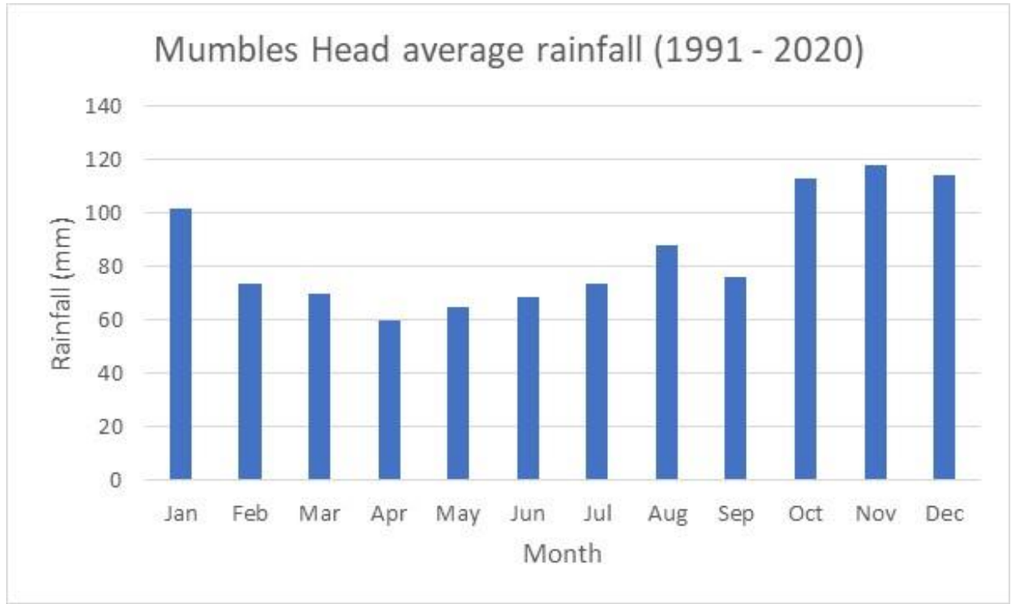
10.5.7 This subsection presents the information gathered on the existing (baseline) topographical, hydrological, geological and hydrogeological (including peat) conditions within Y Bryn Wind Farm.

Climate

10.5.8 The standard average annual rainfall (SAAR) for Y Bryn Wind Farm has been derived from the Flood Estimation Handbook (FEH) Web Service as ranging from 1835 - 2128 mm based on the Y Bryn catchments. To put this into context, rainfall in Wales varies from <1000 mm in places along the coast, to over 3000 mm in Gwynedd.

10.5.9 The Met Office 1981-2010 average annual rainfall total from Mumbles Head (near Swansea) climate station is 999 mm with 147.9 days of rainfall greater than 1 mm recorded. This climate station is located ~ 16 km east of Y Bryn Wind Farm at an elevation of 32 m Above Ordnance Datum (AOD). According to the 1981-2010 average for Mumbles Head climate station, the highest rainfall totals are recorded during the winter months from October through to January as shown in Figure 10.1. Given the station’s distance from and much lower elevation than Y Bryn Wind Farm, average rainfall is much lower than the SAAR derived from the FEH Web Service, however rainfall patterns will be similar.

Figure 10.1: Average monthly rainfall data for climate period 1991-2020 for Mumbles Head Climate Station



Source: Met Office

Designated Sites

10.5.10 There are four designated sites within a 3 km radius of Y Bryn site boundary. Three are designated as a SSSI; Eglwys Nunydd Reservoir, Margam Moors and Cwm Du Woodlands and one as a LNR; Bryn Tip. These are listed in Table 10.6 along with the identification of potential hydrological connectivity between the Y Bryn Wind Farm and the designated site.

Table 10.6: Designated sites in the vicinity of Y Bryn Wind Farm

Designation	Location	Qualifying Feature	Hydrological / Hydrogeological Connection to the Proposed Development
SSSI	Eglwys Nunydd Reservoir	This SSSI is located ~2.4 km to the south of Y Bryn site boundary and is designated for its large number of wintering waterfowl and passage migrants.	No surface water connection to Y Bryn Wind Farm. Down-slope of Y Bryn site boundary, so potential groundwater connection exists, however this is highly unlikely given the distance from the proposed development, topography and geology mapping.
SSSI	Margam Moors	This SSSI is located ~3 km to the south-west of Y Bryn Site Boundary and is designated for fen and marshy grassland mosaic with standing water and associated aquatic invertebrate assemblage.	No surface water connection to Y Bryn Wind Farm. Down-slope of Y Bryn site boundary, so potential groundwater connection exists, however this is highly unlikely given the distance from the proposed development, topography and geology mapping.
SSSI	Cwm Du Woodlands	This SSSI is located ~2.8 km east of Y Bryn Site Boundary and is designated for its semi natural broadleaved woodland, in particular Sessile Oak (*Quercus petraea*).	None. Situated in the catchment of Nant Cwm-du which is topographically and hydrologically separate from the proposed development.
LNR	Bryn Tip	This LNR is located between the Bryn and Penhydd forestry sections directly south of the northern Y Bryn Site Boundary and is designated to protect its historic colliery spoil status and enhance the natural habitat which is home to a number of rare and protected species.	Within surface catchment of Y Bryn Wind Farm. Down-slope of the proposed development so potential groundwater connection exists.

Surface Water Hydrology

10.5.11 Hydrologically, Y Bryn Wind Farm drains into five different river catchments that depending on their course ultimately discharge into Swansea Bay, or the Bristol Channel. There are several tributaries which supply these catchments situated in and around the proposed development. Details on these catchments are presented in Table 10.7. These catchments are discussed in detail in the following paragraphs, and are accompanied by the following figures:

- Figure 10.1: Hydrology Overview;
- Figure 10.2: Topographic Wetness Index; and
- Figure 10.3: Flow Accumulation.

Table 10.7: Surface water catchments associated with Y Bryn Wind Farm site boundary.

Catchment	River Catchment	Description
River Avan/Afon Afan	River Avan/Afon Afan	The River Avan / Afon Afan rises on the northern slopes of Mynydd Llangeinwyr and flows in a general south-westerly direction to the north and north-west of Y Bryn Wind Farm, reaching Swansea Bay at Port Talbot. A number of mapped watercourses from the north section of Y Bryn Wind Farm discharge into the River Avan, the largest of which is Nant Cynon.
Nant Cynon	River Avan/Afon Afan	Nant Cynon rises within the Y Bryn Site Boundary and flows north-west through a gradually steepening valley to discharge into the River Avan just outside the Y Bryn Site Boundary (at approximate National Grid Reference (NGR) SS 81811 95007). The catchment is forested and as such has been subject to man-made drainage primarily ditches and furrows associated with the forestry work. There are several springs mapped.
Ffrwd Wyllt	Ffrwd Wyllt	Ffrwd Wyllt rises in an un-forested area between the Bryn and Penhydd forest sections and flows west south-west, roughly following the site boundary of the south section before reaching Swansea Bay. Ffrwd Wyllt encompasses the greatest catchment area of Y Bryn Wind Farm, with several watercourses including the Nant Drysiog draining the southern part of the north section. Several sub-catchments of the Ffrwd Wyllt are partially or fully within the north and west of the south section, the largest of which are Nant Cwmwernderi and Nant Cym-y-garn.
Nant Drysiog	Ffrwd Wyllt	Nant Drysiog rises in the southern area of the north section. Within the Y Bryn Site Boundary, the catchment area is forested and there are several mapped springs. The headwaters are fairly dendritic and generally flow south and west. The man made drainage channels are largely restricted to furrows associated with tree planting.
Nant-y-boda	Ffrwd Wyllt	Nant-y-boda is almost fully within the Y Bryn Site Boundary and drains the northern area of the south section and also flows in the Ffrwd Wyllt. Flowing north-west through a shallow valley the watercourse joins the Ffrwd Wyllt just outside the Y Bryn Site Boundary. The catchment is fully forested, and several springs are mapped.
Nant Cwmwernderi	Ffrwd Wyllt	This is a large catchment which incorporates the Cwmwernderi Reservoir which is a small reservoir within the south section. The reservoir itself is outside of the Y Bryn Site Boundary but lies within its catchment with some tributaries including the Nant y Glo Fach and Cwm Nant-y-glo that drain the Bryn section feeding the reservoir. The reservoir forms part of the Ffrwd Wyllt catchment and is owned by Dŵr Cymru.
Nant Cym-y-garn	Ffrwd Wyllt	Rises within the south section and flows east through a steep forested valley before its confluence with the Ffrwd Wyllt just outside the Y Bryn Site Boundary.
Afon Cynffig	Afon Cynffig	Afon Cynffig rises on the eastern side of the south section flowing south and then east before discharging into the Bristol Channel south of Eglwys Nunydd Reservoir. Although Afon Cynffig is a larger catchment by area than Ffrwd Wyllt, it only drains a very small area of the proposed development.
Nant Cwmcaetreharn	Afon Cynffig	This watercourse rises on the forested southern slopes of the south section and flows south-west through incised valleys before turning south where it ultimately meets Afon Cynffig south of Eglwys Nunydd Reservoir.
Arnallt Brook	Arnallt Brook	This watercourse is another sub-catchment which rises on the forested southern slopes of the south section and flows south-west through incised valleys before entering artificial drainage channels in Margam. It also hosts the Brombil Reservoir on its course.
The Llynfi River / Afon Llynfi	The Llynfi river / Afon Llynfi	The Llynfi river rises on the eastern side of Mynydd Caerau, north of Maesteg and runs south until it meets the Ogmore River (Afon Ogwr) near Bridgend. The Llynfi River drains the eastern sides of both the north and south sections, however similar to Afon Cynffig, although the river has one of the larger catchments, it is only responsible for draining a small percentage of Y Bryn Wind Farm.
Eglwys Nunydd Reservoir	N/A	Eglwys Nunydd Reservoir, discussed in the Designated Sites sub section is a SSSI that could also be hydrologically connected through groundwater.

10.5.12 Photographs taken during the site visits of the typical site hydrology and catchments described in Table 10.7 are provided.

Source: Natural Power

Photograph 10.1: Headwaters of Nant Drysiog.

Source: Natural Power

Photograph 10.2: Nant y Glo Fach.

Source: Natural Power

Photograph 10.3 Cwmwernderi Reservoir.

Source: Natural Power

Photograph 10.4: Headwaters of Nant Goblyn (Llynfi River tributary). Photo highlights step at edge of the upland plateau.

Additional Drainage

10.5.13 There are extensive forestry works within the proposed Y Bryn Site Boundary with regular furrows and ridges across all site catchments increasing functional drainage of the land. There is also some evidence of artificial drainage ditches, although these are sporadic which ultimately feed into the watercourses of forested catchments.

Hydrological Regime

10.5.14 Base Flow Index (BFI) and Standard Percentage Runoff (SPR) data for the catchments covering the proposed development have been calculated. The BFI is a measure of the proportion of a catchment's long-term runoff that derives from stored sources, with the BFI ranging from 0.1 in relatively impermeable catchments to 0.99 in highly permeable catchments. The SPR values represent the percentage of rainfall that is likely to contribute to runoff.

10.5.15 The BFI value for the catchments within the site is approximately 0.43[3]. This indicates approximately just under a half of streamflow within the proposed development is derived from stored sources such as groundwater. For the site catchments groundwater contribution to flow is moderate. The SPR values for these catchments range from 37% to 53%, indicating that approximately just over a third to half of the rainfall during a rainfall event contributes to runoff.[4]

10.5.16 Figure 10.2 provides information on the flow direction of the surface runoff within the site boundary. Flow accumulation is based on the 5 m resolution Digital Terrain Mapping (DTM) of the area occupied by the proposed development. The flow accumulation represents the volume of water that would flow into each 5 m cell of the DTM, assuming that all water becomes runoff and there was no interception, evapotranspiration or infiltration. The volume of accumulation is represented in greyscale with higher flow accumulations being darker in shade to areas with lower flow accumulation. This figure illustrates the influence of topography on the accumulation and direction of surface water runoff across the proposed development.

10.5.17 Figure 10.3 provides information on how the topography influences the surface saturation of the peat and soils across the proposed development. The analysis of the DTM derived a topographic wetness index (TWI). The TWI is a dimensionless index, defined by the equation: In (a/tan b) where a = area draining through a point from an upslope contributing area and tan b is the local slope angle. The index provides results on the hydrological similarity of peat. All points with the same value of the index are assumed to respond in a similar hydrological manner. High index values will tend to saturate first and will therefore indicate potential subsurface or high surface runoff areas.

10.5.18 As shown in Figure 10.3, the TWI for the proposed development has identified those areas where water will accumulate on site and result in saturation of the surrounding soils and peat. The highest values (13.5 plus) in the TWI form linear channels or where areas have a tendency to become saturated, are shown in blue and drier areas where there may be less tendency for the ground to saturate, are shown in yellow and orange. The dark blue linear channels are considered to show achievable flow rates that are likely to occur throughout the year or during extreme rainfall events. The lighter blue is likely to represent areas of the proposed development where the topography allows the accumulation and potential saturation of soils from shallow subsurface or surface during prolonged and/or intense rainfall events. Whilst it is recognised that other areas of the proposed development are likely to become saturated, it is expected that any saturation will be dependent upon climatic conditions such as the intensity and duration of rainfall. Figure 10.3 suggests that away from the watercourses, riparian corridors, man-made furrows and drainage channels and flatter ground, that the areas of the proposed development where are generally dry with TWI at the lower end of the range.

Flood Risk

10.5.19 A qualitative flood consequence assessment has been undertaken where the risks of flooding have been considered from all potential sources which are listed and with reference to NRW's Flood Map[5]. The assessment has considered the flood risk to the proposed development as well as the potential to increase flooding downstream that could be caused by the proposed development.

Fluvial and Pluvial Flooding

10.5.20 A review of NRW's Flood Map indicates that the Nant Cwmwernderi, within the proposed site boundary, has a medium (between 1 in 100 year event to a 1 in 30 year event) risk of flooding. This appears to be confined to the riparian zone of the channel. Within the Y Bryn site boundary there is mainly a low (between 1 in a 1000 year event) to medium (1 in a 100 year event) risk of flooding from surface waters, but again, this is primarily confined to the riparian zones of watercourses and scattered across the proposed development area in topographic hollows.

Flooding from Reservoir Extents

10.5.21 The Nant Cwmwernderi watercourse within the site boundary and the Cwm Dyffryn watercourse which the Cwm Wernderi feeds into, are at risk of flooding from reservoirs. This does not extend beyond the functional flood plain.

Tidal Flood Sources

10.5.22 The Y Bryn Site Boundary is approximately 3 km away from the nearest coast. However, given the topographical position of the proposed development it will not be affected by tidal flooding and is not discussed further in this chapter.

Groundwater Flood Sources

10.5.23 Flooding can also result from high groundwater levels if the water table rises above the surface level. Groundwater flooding happens in response to a combination of already high groundwater levels (usually during mid- or late-winter) and intense or unusually lengthy storm events. Groundwater flooding is difficult to predict as it rarely follows a consistent pattern. The response time between rainfall and groundwater flooding is also relatively long.

10.5.24 Groundwater flooding is often associated with the shallow unconsolidated sedimentary aquifers that over lie non-aquifers. Such aquifers are susceptible to flooding as the storage capacity within these deposits is often limited

[3] Natural River Flow Archive (2022) Available from https://nrfa.ceh.ac.uk/ [Accessed 05/08/2022].

[4] HR Wallingford Tools for Sustainable Drainage Systems. Available from https://www.uksuds.com/ [05/08/2022].

[5] NRW. (2018) *Long term flood risk*. [Online]. Available from https://naturalresources.wales/evidence-and-data/maps/long-term-flood-risk/?lang=en [Accessed 05/08/2022].

and direct rainfall recharge can be relatively high, subsequently increasing the water levels within the groundwater. Further information on the superficial geology is provided.

Flooding from Artificial Drainage

10.5.25 There is evidence of artificial drainage (furrows and ditches) associated with forestry works within both the north and south sections of the proposed development. There is the potential that this could cause some localised flooding by increasing runoff rates to the watercourses that they drain to within the surrounding area.

Flooding Down Catchment

10.5.26 As the topographic setting changes from an upland associated with the proposed development to a relative lowland setting it is unsurprising that the flood risk mapper[5] shows an increased risk of flooding down catchment. The watercourses draining from the proposed development are typical upland channels with small catchment areas that discharge into main rivers with wide floodplains that are at greater risk of flooding due to the cumulative volumes of water flowing within the channels as a result of the increased catchment area. Properties within the floodplain of Ffrwd Wyllt, downstream of the proposed development, are located within the floodplain of the river. The River Afan also has a high to low risk of flooding along most of its course, this is generally well confined, but it also has a wider floodplain mapped where it flows through Cwmafan and again in Port Talbot. NRW is progressing a Natural Flood Management (NFM) pilot project in the Ffrwd Wyllt catchment (northern part of the south section and southern part of the north section) to take a holistic approach to catchment management, comprising interventions in the headwaters to slow the flow of water and reduce flooding. The Ffrwd Wyllt is a catchment that is approximately 20 hectares (ha) and is characterised by steep forested valley. It is up catchment of Taibach which is a community with a 1 in 30 chance of flooding each year without significant flood defence.[6] Further details on enhancement of existing NFM work in included in Appendix 6.3: Outline Habitat Management Plan.

Water Quality

WFD Classification

10.5.27 There are three River Basin Management Plans (RBMP) which cover Wales and the proposed development is within the 'Western Wales River Basin District'. The RBMP are one of the requirements of the Water Framework Directive (WFD) (2000/60/EC) and are the plans designed for protecting and improving the water environment. A number of waterbodies within the vicinity of the proposed development have been classified under NRWs RBMP (NRW 2018). Table 10.8 details the classified watercourses associated with the proposed development.

Table 10.8: RBMP classification of surface waterbodies and groundwater within the vicinity of the proposed development

Waterbody	Current Overall Interim Status (2018)	Ecological	Chemistry	Fish	Quantitative
Afan - confluence with Corrwg to confluence with Pelenna	Moderate	Moderate	Fail	Moderate	n/a
Afan - confluence with Pelenna to tidal limit	Good	Good	Good	n/a	n/a
Ffrwd Wyllt - headwaters to tidal limit	Moderate	Moderate	Fail	Moderate	n/a
Llynfi - headwaters to Lletty Brongu STW (Sewage Treatment Works)	Moderate	Moderate	Good	Moderate	n/a
Swansea Carboniferous Coal Measures (Groundwater)	Poor	-	Poor	-	Good

10.5.28 None of the watercourses within the site boundary or proposed development are classified within the RBMP.

Effects of Peat on Water Quality

10.5.29 As discussed in later sections of this chapter, peat soils are present within the Y Bryn Site Boundary and as such will exert an influence on the water quality within surface bodies, particularly during storm events or prolonged dry spells where soils are noted to be eroded or degraded. Effects within the UK are most commonly associated with discolouration arising from high levels of dissolved iron and dissolved organic carbon (DOC), of which the concentrations for the latter have been noted to increase steadily across Europe since the 1970s and is a trend which is predicted to continue.[7] Whilst the mechanism facilitating these increases is highly speculated, the ultimate removal of DOC is a major component of potable water treatment particularly in catchments dominated by peat.

Effects of Forestry on Water Quality

10.5.30 It is possible that the addition of ridge and furrow structures associated with the planting of the forestry across both the north and south section could result in greater sediment export in the short term as a result of soil disturbance The effects of productive forestry within upland catchments vary depending on the effectiveness of the associated management strategy but may including enhanced base-ion removal from groundwater, the accumulation of atmospherically scavenged species in soils, all of which may result in a reduction of the acid neutralising capacity and consequential acidification of surface water networks[8].

10.5.31 The trees across the proposed development vary in age. In areas of younger plantation, it is unlikely that the presence of the trees would be currently imparting an effect flow rates. Areas of mature forestry help to attenuate peak flows due to the interception of precipitation by the closed canopy. Research into the effects on the hydrological regime of catchments suggests that forestry practices can have impacts on peak flows; and subsequently flood risk. Research also suggests that there may be a 1.5% – 2 % reduction of potential water yield for every 10 % of a catchment under mature conifer forest[9]. In areas to be felled, a reduction in forestry cover will lead to a reduction in interception of precipitation. Forestry operations are required to adhere to industry standards so as not to lead to a subsequent increase in runoff and water yield.

Effects of Coal Mining on Water Quality

10.5.32 The proposed development lies within the Western Wales River Basin District which has a long legacy of both mining and quarrying. Mining legacy has resulted in pressure on water quality from two sources, the underground workings and waste materials spread on the surface. Groundwater leaching from abandoned mines can be contaminated with iron, zinc, lead, cadmium, manganese, copper, nickel, arsenic and can also be quite acidic.

[6] NRW *et al.* (2001) Natural Flood Management at Scale: Ffrwd Wyllt Catchment

[7] Xu *et al.* (2020) Increased Dissolved Organic Carbon Concentrations in Peat-Fed UK Water Supplies Under Future Climate and Sulfate Deposition Scenarios

[8] Puhr, C.B., Donoghue, D.N.M., Stephen, A.B., Tervet, D.J. and Sinclair, C., 2000. Regional patterns of stream water acidity and catchment afforestation in Galloway, SW Scotland. Water Air Soil Pollution., 120, 47–70

[9] Forestry Commission (2011), Forests and Water, UK Forestry Standard Guidelines. Edinburgh.

This pollution can have significant ecological impacts some from the direct toxic impact on biology and the smothering impact of sludge and solids on riverbed gravels which affects invertebrates and fish spawning[10].

10.5.33 The legacy of coal mining within the area of the proposed development has the potential to influence the baseline water quality of surface and groundwaters. Even after mining has ceased there is still potential for river pollution, causing harm to aquatic fauna and ecosystems. For the watercourses draining the proposed development there is potential for there to be low pH and elevated concentrations of iron, aluminium and sulphates in the watercourses[11]. This could be the reason for the 'Fails' for Chemistry shown in Table 10.8. The extent of historic coal mining is discussed further in Appendix 10.2: Coal Mining Risk Assessment.

Geology

10.5.34 Bedrock Geology has been scoped out of requiring further assessment within this chapter. However, bedrock geology is discussed with Appendix 10.2: Coal Mining Risk Assessment.

Coal Mining Assessment

10.5.35 The risk to the proposed development from historic coal mining has been assessed, in Appendix 10.2. The assessment concludes that there is potential for infrastructure associated with the proposed development to be underlain by historical workings although only five of the identified features (T01, T06, T15, Penhydd Mast and Penhydd Entrance construction compound) are within areas defined by the Coal Authority as high risk (i.e., shallow coal workings potentially present) and nine other features are located close to such areas. It is concluded in the report that there is potential for historical coal mining to have a significant impact on proposed development features without mitigation, however in most cases these effects can be mitigated through micrositing, the treatment of workings and/or the deepening of foundations beneath zones of workings/collapse. Further investigation works, comprising location specific intrusive ground investigation and coal mining risk assessment will be undertaken at each of the proposed development features prior to commencement of construction, to confirm the presence/absence of historical workings and associated risks posed. Any remediation works identified shall be carried out to the satisfaction of the Local Planning Authority (LPA) in consultation with the Coal Authority and it is expected that a planning condition is imposed of a planning consent relating to coal mining.

Hydrogeology

10.5.36 The majority of Y Bryn Wind Farm is underlain by a moderately productive aquifer associated with the South Wales Upper Coal Measure Formation. The aquifer is a regional, cyclic multi-layered aquifer with moderate yields from sandstones and many springs, however mine water quality is poor. In the north section, the site boundary is also underlain by the moderately productive aquifer of the South Wales Middle Coal Measures Formation which exhibits the same characteristics as the Upper Coal Measure Formation. The hydrogeological units are summarised in Table 10.9.

Table 10.9: Hydrogeological units

Element	Type	Comments
South Wales Middle Coal Measures Formation: Mudstone, Siltstone and Sandstone.	Sedimentary	These sedimentary rocks are fluvial, palustrine and shallow-marine in origin. They are detrital, forming deposits reflecting the channels, floodplains and deltas of a river in a coastal setting (with periodic inundation from the sea).
South Wales Upper Coal Measures Formation: Rhondda Member Sandstone.	Sedimentary	These sedimentary rocks are fluvial in origin. They are detrital, ranging from coarse- to fine-grained and form beds and lenses of deposits reflecting the channels, floodplains and levees of a river or estuary (if in a coastal setting).
South Wales Upper Coal Measures Formation: Brithdir Member - Sandstone.	Sedimentary	These sedimentary rocks are fluvial in origin. They are detrital, ranging from coarse- to fine-grained and form beds and lenses of deposits reflecting the channels, floodplains and levees of a river or estuary (if in a coastal setting).
Llynfi Member - Mudstone, Siltstone and Sandstone	Sedimentary	These sedimentary rocks are fluvial in origin. They are detrital, ranging from coarse- to fine-grained and form beds and lenses of deposits reflecting the channels, floodplains and levees of a river or estuary (if in a coastal setting).
Till	Superficial deposit	These sedimentary deposits are glacigenic in origin. They are detrital, created by the action of ice and meltwater, they can form a wide range of deposits and geomorphologies associated with glacial and inter-glacial periods during the Quaternary.
Peat	Superficial deposit	These sedimentary deposits are lacustrine and palustrine in origin. They comprise accumulated (and detrital) organic material, forming beds and lenses within lagoons, bogs and swamps.

Source: British Geological Society (BGS)

Groundwater Dependent Terrestrial Ecosystems

10.5.37 National Vegetation Classification (NVC) surveys have been undertaken and are discussed in Chapter 6: Ecology. As part of the scoping report some of the NVC habitats were identified as having potential to be groundwater dependent terrestrial ecosystems (Section 10.5 of scoping report, found in Appendix 3.1 of this ES). These potential GWDTE are shown on Figure 10.5. An assessment of the likelihood of these habitats actually being dependent on groundwater has been undertaken.

10.5.38 The soils and peat underlying the proposed development have been extensively surveyed and cored, and the findings are discussed in sub-section 'Soils and Peat' in in this chapter. These surveys identified that generally the site is underlain by a thin peat soil and then clay, which is assumed to extend to the bedrock. These soil profiles were observed during the coring exercise and are corroborated by geological mapping (see also Paragraph 10.5.52 -10.5.54). The clay subsoil would act as an aquiclude, impeding the emergence of any diffuse groundwater flow meaning that the habitats are nourished by direct rainfall and overland flow. In this regard, the accumulation of surface water and ombrotrophic habitat occur both as a result of the convergence of these surface flows and limited opportunities for infiltration through the clay and bedrock. This is demonstrated in the predominance of potential GWDTE communities to accumulate within artificial drainage features, or areas of constrained topography such as re-entrants, forest rides etc. As such, it considered that these habitats are not reliant on groundwater and

[10] Environment Agency (2009) Water for life and livelihoods - River Basin Management Plan Western Wales River Basin District Annex C: Actions to deliver objectives. Available from https://naturalresources.wales/media/675074/annex-c.pdf [Accessed 05/08/2022]

[11] Environment Agency (2019) 2021 River Basin Management Plan – Mine Waters Challenge. Available from https://consult.environment-agency.gov.uk/environment-and-business/challenges-and-choices/user_uploads/pollution-from-abandoned-mines-challenge-rbmp-2021-1.pdf [Accessed 05/08/2022].

are not actual GWDTEs and therefore the SEPA Land Use Planning System (LUPS) 31 buffers (as no equivalent in Wales) need not apply.

10.5.39 Notwithstanding this, the majority of GWDTE's are primarily in the valleys of watercourses and areas of deeper peat where there is no infrastructure proposed and where a 50 m watercourse buffer is already present. Again, these locations suggest that it is surface saturation as opposed to groundwater in these areas. It is also highlighted that there are designated sites of ecohydrology/GWDTE interest within the site boundary.

Water Resources

Public Resources

10.5.40 There are no mapped Drinking Water Protected Areas (Lake or River) within or within the vicinity of the Y Bryn Site Boundary.

Private Water Supplies

10.5.41 NPTCBC and BCBC provided information on PWS within 3 km of the Y Bryn Wind Farm Site Boundary (i.e., northern and southern forestry sections) and within 2 km of the new access routes from M4 and AIL access roads. NPTCBC identified 40 properties and BCBC identified 20 properties within the search area as potentially utilising a PWS.

10.5.42 In order to determine the potential risks to the identified PWS, a source-pathway-receptor approach has been adopted to initially screen whether a pollutant linkage could exist between the proposed development and the water supply. Where PWS abstractions could be conceivably "hydrologically connected" (either by means of overland or groundwater flow) then further, more detailed assessment was undertaken to qualify the level of risk. Based on the hydrological and hydrogeological setting of the proposed development, it is considered that only PWS abstractions within the proposed development or up to 3 km of the Y Bryn Site Boundary could be hydrologically or hydrogeologically connected.

10.5.43 An initial desktop screening assessment adopting the source-pathway-receptor approach was undertaken to screen out any PWS abstractions that are not hydrologically (surface and groundwater) connected to the proposed development. Criteria for screening out was based on the abstraction and supporting infrastructure either being in a separate catchment or sub catchment to the proposed development, the abstraction and supporting infrastructure was sufficiently up catchment or separated by intervening built infrastructure such as towns and major roads from the proposed development. Of the 60 abstractions identified, 42 were screened out on this basis, 32 in NPTCBC area and 10 in BCBC area.

10.5.44 A list of all properties identified by NPTCBC and BCBC can be provided on request. For the 18 properties that weren't initially screened out, consultation with owners was undertaken through the submission of a questionnaire, requesting details concerning the abstraction location, the location of delivery infrastructure and general anecdotal information on temporal changes in water quality and quantity. Further information obtained from each supply are presented in Table 10.10.

Table 10.10: PWS with potential connection to the proposed development

ID	PWS Supply Name (Provided by Local Authority)	Property Easting	Property Northing	Local Authority	PWS Type	PWS Distance from nearest infra. (Approx. (km))	Response to Questionnaire	Notes	Require Further Consideration	Mitigation
4	The Grange Cottage	280105	189883	NPTCBC	Unknown	0.80	No	Possible hydrological connection to the proposed development, PWS abstraction could be within the site boundary	Yes	Whilst the abstraction location could not be confirmed. there are several mapped springs in the vicinity of the property. Additional mitigation involves further investigations post consent to verify the abstraction location and supply infrastructure.
5	Crugwyllt Fawr Farm	279767	187050	NPTCBC	Spring and Borehole	1.05	Yes	Given topography and distance from closest infrastructure (site access track) it appears that this PWS is not hydrologically connected to the proposed development	No	No additional mitigation required
6	Tan y Coed Farm	281442	192148	NPTCBC	Unknown	1.48	No	Given location relative to the proposed development, topography and distance from closest infrastructure it is highly unlikely that this PWS abstraction is hydrologically connected to the proposed development	No	No additional mitigation required.
8	Brombil House	279766	187911	NPTCBC	Surface	0.69	No	Appears to be topographically and hydrologically separated from proposed development.	No	No additional mitigation required
9	The Grange Hafod Farm	280105	189884	NPTCBC	Unknown	0.80	No	Possible hydrological connection to the proposed development, PWS abstraction could be within the site boundary	Yes	Whilst the abstraction location could not be confirmed. there are several mapped springs in the vicinity of the property. Additional mitigation involves further investigations post consent to verify the abstraction location and supply infrastructure.
17	Crugwyllt Fach Farm	279783	187009	NPTCBC	Unknown	1.05	No	Given location relative to the proposed development, topography and distance from closet infrastructure it is unlikely that this PWS abstraction is hydrologically connected to the proposed development	No	No additional mitigation required
25	Llety Piod Farm	278420	189334	NPTCBC	Spring and Borehole	0.89	Yes	Spring abstraction and borehole are within a hydrologically separate catchment to the proposed development infrastructure.	No	No additional mitigation required
29	Tyla Farm	279195	187635	NPTCBC	Spring	0.24	Yes	Response indicates that the source of the spring is on the opposite side of the valley to the proposed site access route	No	No additional mitigation required
44	Cae Emi Farm	284567	189251	BCBC	Spring	1.44	No	Given topography and distance from closest infrastructure it is unlikely that this PWS is hydrologically connected to the proposed development	No	No additional mitigation required

ID	PWS Supply Name (Provided by Local Authority)	Property Easting	Property Northing	Local Authority	PWS Type	PWS Distance from nearest infra. (Approx. (km))	Response to Questionnaire	Notes	Require Further Consideration	Mitigation
46	Blaen-cwmcerwyn Farm	283384	190166	BCBC	Borehole	0.50	No	Borehole is likely to draw water from different subsurface layer than the shallow foundations associated with the proposed development. Potential for siltation at surface and subsurface low if good practice mitigation is followed.	No	No additional mitigation required
47	Cae Emi Farm	284567	189239	BCBC	Borehole	1.48	No	Borehole is likely to draw water from different subsurface layer than the shallow foundations associated with the proposed development. Potential for siltation at surface and subsurface low if good practice mitigation is followed.	No	No additional mitigation required
49	Ty Llath @ Pentre Farm	285116	189434	BCBC	Spring and Borehole	2.00	Yes	Questionnaire response confirms borehole and spring supply. Borehole is likely to draw water from different subsurface layer than the shallow foundations associated with the proposed development. Spring is highly likely to be topographically separate given distance from proposed development and on opposite slope of the hillside.	No	No additional mitigation required
50	Cwmcerwyn	283789	190860	BCBC	Spring	0.50	Yes	Property owner confirmed location of the abstraction. The supply is located within the catchment of a tributary to the Nant which does not contain any infrastructure associated with the proposed development.	No	No additional mitigation required
54	Ukn	284700	192500	BCBC	Borehole	0.60	No	Borehole is likely to draw water from different subsurface layer than the shallow foundations associated with the proposed development	No	No further action required
55	Ukn	284700	192500	BCBC	Spring	0.60	No	Location of the property in relation to the proposed borrow pit means that it is highly unlikely to be impacted by the proposed development. This would be confirmed prior to construction.	No	No additional mitigation required
56	Blaen-cwmcerwyn Cottage (Highland Heights)	283168	190264	BCBC	Spring and Borehole	0.52	Yes	Location and likely depth of groundwater borehole means that it is likely to be drawn from deeper strata and should not be affected by construction of the proposed development. Evidence of possible PWS infrastructure (manhole cover and holding tank) were noted at this location during the site visit. Response to questionnaire confirms locations of the spring as within the catchment of link road between the north and south section	Yes	Additional mitigation involves further investigations post consent to verify the abstraction location and supply infrastructure. Mitigation includes demark potential spring catchment area. Good practice management of track runoff and maintenance of track side drainage.

ID	PWS Supply Name (Provided by Local Authority)	Property Easting	Property Northing	Local Authority	PWS Type	PWS Distance from nearest infra. (Approx. (km))	Response to Questionnaire	Notes	Require Further Consideration	Mitigation
57	Blaen-cwmcerwyn (The Pines)	283398	190198	BCBC	Spring	0.29	No	Evidence of Possible PWS infrastructure (manhole cover and holding tank) were noted at this location during the site visit. Spring possibly within the catchment of link road between the north and south section	Yes	Whilst the abstraction location could not be confirmed. there are several mapped springs in the vicinity of the property. Additional mitigation involves further investigations post consent to verify the abstraction location and supply infrastructure. Mitigation includes demark potential spring catchment area. Good practice management of track runoff and maintenance of track side drainage.
59	Ffermdy Lluest-wen	284200	189000	BCBC	Springs	1.08	Yes	Location of the two spring abstractions mean it is highly likely that they are within a hydrologically separate catchment to the proposed development infrastructure.	No	No further action required.

Soils and Peat

10.5.45 The distribution and quality of soils across the Y Bryn Site Boundary is dependent upon land use, geology, topography and hydrological regime of the area. Information on the proposed development soils has been obtained from UK Soil Observatory (UKSO)[12]. The mapper indicates that the dominant soil types are very acid/loamy soils with a wet peaty surface, freely draining acid loamy soils and slowly permeable wet very acid soils with a peaty surface. The quality of the soils has been affected by the existing land use, including productive forestry and associated ridges and furrows as well as artificial drainage ditches to dry the soils.

10.5.46 Peat is a soft to very soft, highly compressible, highly porous organic material that can consist of up to 90% – 95% water, with 5% – 10% solid material[13]. Unmodified peat consists of two layers; a surface acrotelm which is usually 10 cm – 30 cm thick, highly permeable and receptive to rainfall. Decomposition of organic matter within the acrotelm occurs aerobically and rapidly. The acrotelm generally has a high proportion of fibrous material and often forms a crust in dry conditions.

10.5.47 A second layer, or catotelm, lies beneath the acrotelm and forms a stable colloidal substance which is generally impermeable. As a result, the catotelm usually remains saturated with little groundwater flow. Peat is thixotropic, meaning that the viscosity of the material decreases when stress is applied. The thixotropic nature of peat may be considered less important where the peat has been modified through artificial drainage or natural erosion and is drier but will be significant when the peat body is saturated.

10.5.48 Due to soils mapping, in particular the Unified Peat Map of Wales[14], suggesting the distribution of peat and peaty soils underlying the proposed development, a Phase 1 peat depth survey, followed by Phase 2 detailed probing and coring has been carried out to thoroughly understand the peat and its locality within Y Bryn site boundary.

Peat Survey Results

10.5.49 The following information provides a summary of the soil and peat depths recorded during field surveys.

10.5.50 Peat survey data has been collected in line with the recommended statutory approach, comprising of initial phase 1 (100 m grid) surveys, followed by more detailed Phase 2 (targeted) surveys. The results of the phase 1 surveys were used to inform preliminary design, before refinement following completion of the Phase 2 surveys. The detailed Phase 2 surveys were undertaken in October and November 2021 and January, March and April 2022 and concentrated to areas where it was possible that there was a peat depth >0.3 m (based on desk study and phase 1 surveys). The resolution of the peat surveys was a 20 m grid across turbines and crane pads, and every 20 m along each side of existing access roads.

10.5.51 Owing to the underlying geology there is a presence of superficial clay across the site. In many areas the clay was easily penetrable by the probes used to measure the peat depth, and therefore the depths recorded during the 100 m grid survey were the depth of the soil column rather than just peat. During phase 2 peat surveys in areas where measured depths were consistently ≥0.3 m, in line with NRW guidance, soil cores were taken at 52 locations to characterise the soil column. This allowed the actual peat soil depth to be measured relative to total probed depth. Probed depths surrounding the soil core have been corrected based on that core and the results in Table 10.11 are the corrected peat soil depths. Areas where measured peat depth is ≥0.3 m are discussed.

[12] UKSO (2018). *UK Soil Observatory map viewer.* [Online]. Available from https://mapapps2.bgsVpo.ac.uk/ukso/home.html [Accessed 05/08/2022]

[13] Warburton *et al.* (2004) Hydrological controls of surficial mass movements in peat

[14] Welsh Government (2015). Unified Peat Map of Wales. [Online] Available from https://lle.gov.wales/catalogue/item/UnifiedPeat [Accessed 05/08/2022]

Table 10.11: Total number of soil depths surveyed within each category during the phase 1 and phase surveys

Total Soil Depth (m)	Results	% of Points
<0.3	1894	86.4
≥0.3 - <0.5	198	9.0
≥0.5 - <1	92	4.2
≥1 - <1.5	7	0.3
≥1.5 - <2	0	0
≥2	2	0.1
Total	**2193**	**100**

Source: Natural Power

10.5.52 Table 10.11 shows that the majority (~86%) of recorded depths fell within the <0.3 m range, with the next highest proportion (~9%) within the ≥0.3 - <0.5 m range. Taking into account the results of the cores, the areas of deeper peat soils (≥0.3 m) as shown on Figure 10.4 are restricted to the plateau between Nant-y-glo and Nant Sychbant (primarily between T9 and T10), parts of the north slope of Mynydd Margam (primarily around the access track to T16), the plateau around Brynallwyn (north-east of T12), and a small area in the north section south of the main access track for T1 – T5. Any other areas of deep peat were localised to within the vicinity of small valleys or watercourses across the Y Bryn Site Boundary and well away from areas of infrastructure associated with the proposed development. The area of deepest peat identified was the plateau between Nant-y-glo and Nant Sychban however although this is relatively near proposed infrastructure this has been avoided.

10.5.53 Table 10.12 highlights the results of cores taken from turbine centres (of the "design chill" layout, see Chapter 4) from which the phase 1 peat probing indicated that there was potential for peat (≥0.3 m) with example photographs of cores. Since the design freeze Turbine 7 has been relocated, however the results of the core have been left in the table to demonstrate how the site design considered peat as a constraint. Table 10.12 provides a summary of the peat depth (corrected based on core depth) at each turbine location.

Table 10.12 Total core depth and peat depth of cores taken at "design chill" turbine centres within potential extent of deep peat

Turbine ID Design Freeze	Turbine ID Design Chill	Total Depth (m)	Peat Depth (m)
3	4	0.23	0.10
-	7	0.56	0.25
6	8	0.37	0.17
9	11	0.42	0.42
10	12	0.50	0.20
11	13	0.35	0.30
13	15	0.35	*
16	18	0.34	0.25
18	20	0.39	0.19

** Soil profile overturned by forest operations*

Source: Natural Power

10.5.54 Table 10.13 provides a summary of the nearest peat depth to each turbine location (for the final design freeze layout). Detailed probing has not been undertaken at directly design freeze locations T6 and T7 although there is detailed probing at T6 for the adjacent access track. Based on previous site survey and resultant interpolation this provides enough information to show that the turbines are on shallow soils rather than peat. Average peat depth across the turbine locations is 0.20 m.

Table 10.13: Peat depth at design freeze turbine locations

Turbine ID	Probe Depth (m)*
1	0.10
2	0.20
3	0.10
4	0.20
5	0.20
6	0.20*
7	0.20*
8	0.10
9	0.20
10	0.20
11	0.30
12	0.30
13	0.10
14	0.20
15	0.20
16	0.25
17	0.20
18	0.19

**Where no peat core was taken, peat depth was measured to the nearest 0.1m using a peat probe*

10.5.55 The core and site photos also demonstrate that even when a deeper peat sample was taken that the peat was dry with a soil like texture and limited water content. Von Post scores carried out through lab analysis verify the onsite observation with turbine scores of H2 to H4 (Table 10.14).. On the whole, where encountered, deeper probe depths were often made up largely of peaty soil rather than peat, particularly where forest operations have led to increased drainage (photographs 10.7 – 10.11). Additionally, no evidence of slope or soil instability (e.g., soil creep, slope failure) was encountered on site.

Source: Natural Power

Photograph 10.5: T10 centre core (0.2 m peat).

Source: Natural Power

Photograph 10.6: Near T16 showing clay soils at surface.

Source: Natural Power

Photograph 10.7: 1 m core entirely comprised of clay from probe depth of 2.7 m (top 1 m cored) in the north section (NGR 283038 193071) on the track leading to T3).

Source: Natural Power

Photograph 10.8: Water pooling in furrows observed extensively throughout the forestry in both north and south sections of the proposed development.

Photograph 10.9: T18, pooling water directly on top of clay soils. Ridges in area developed with soils from furrows.

Photograph 10.10: Core from the centre of T3 demonstrating dry soil with high organic content ~0.1 m depth on top of clay.

Source: Natural Power

Photograph 10.11: Taken at location of T17 soil shows evidence of sand and grains.

Photograph 10.12: Core at design chill T7 shows some peat, but core was in a small deciduous part of the area. 0.45 m peat, low water content.

Table 10.14: Von Post Humification Scale

Location	Easting	Northing	Von Post Score	Description*
Plateau area	282820	189583	H7	Brown Peat – Strongly decomposed peat with much amorphous material and faintly recognisable plant structure. On squeezing, about one half of the peat is extruded. The water is very dark in colour.
Near Access track to Turbine 17	282546	189119	H3	Brown Peat - Very slightly decomposed peat, containing a little amorphous material. On squeezing, muddy brown water but no peat passes between the fingers. Residue is not pasty.
Previously considered turbine location (“design chill” T7)	282136	190907	H4	Brown Peat – Slightly decomposed peat containing some amorphous material. Strongly muddy brown water but no peat passes between the fingers. Residue is somewhat pasty.
Previously considered turbine location (“design chill” T8)	282528	190718	H2	Brown Peat - Nearly undecomposed peat, free of amorphous material, yielding only yellowish brown water on pressing.
Turbine 9	282490	189646	H3	Brown Peat -Very slightly decomposed peat, containing a little amorphous material. On squeezing, muddy brown water but no peat passes between the fingers. Residue is not pasty.
Turbine 10	282783	189343	H3	Brown Peat -Very slightly decomposed peat, containing a little amorphous material. On squeezing, muddy brown water but no peat passes between the fingers. Residue is not pasty.
Turbine 13	281299	189545	H2	Brown Peat - Nearly undecomposed peat, free of amorphous material, yielding only yellowish brown water on pressing.
Turbine 16	282459	188852	H8	Strongly decomposed peat with much amorphous material and very indistinct plant structure. On squeezing, two thirds of the peat and some water passes between the fingers. Residue consists of plant tissues capable of resisting decomposition (roots, fibres, wood, etc.).
Turbine 18	281227	188966	H2	Brown Peat - Nearly undecomposed peat, free of amorphous material, yielding only yellowish brown water on pressing.

** Von Post Humification Scale available from https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2018/12/peatland-survey-guidance/documents/peatland-survey-guidance-2017/peatland-survey-guidance-2017/govscot%3Adocument/Guidance%2Bon%2Bdevelopments%2Bon%2Bpeatland%2B-%2Bpeatland%2Bsurvey%2B-%2B2017.pdf [Accessed 26/05/2022]*

10.5.56 In summary, based on peat survey results (displayed in Figure 10.4), it is concluded through a combination of probing and coring that the site is predominantly underlain by soils with a peat content. There is a very limited presence of peat on site and there is extremely limited presence of peat ≥0.5 m and where this deepest peat is present it is situated away from areas of infrastructure and is predominantly confined to the areas of the upland plateau described above. The survey indicates that peat depths are also consistently shallow mostly ≤0.3 m and almost entirely <0.5 m.

10.5.57 As a result of the extensive site investigations and peat surveys, there is no peat over 0.5 m underlying proposed infrastructure and no peat on steep slopes. The design evolution of the infrastructure layout carefully avoided deep peat and was a key consideration throughout the design process. There was also no evidence of slope instability therefore the need for a peat slide risk assessment has been scoped out. Given that there is concluded to be no peat requiring excavation and handling a peat management plan has also been scoped out. Good practice soil handling and management is outlined in paragraphs 10.7.49 – 10.7.64. The coring suggests the presence of soils with peat content rather than peat underlain by clay.

10.5.58 The peat depth values and hydrological characteristics for the site identified as part of the baseline has been fed into a carbon balance assessment which further assesses the potential effects of the proposed development on carbon dioxide emissions (see Appendix 10.4 for full copy of report and its conclusions). Although the phase 1 and phase 2 peat surveys indicated minimal areas of deep peat within the site boundary, for completeness, a carbon balance assessment was undertaken.

Modifying Influences

10.5.59 Information regarding climate change was obtained from the UK Climate Projections (UKCP18) website[15]. The UKCP18 is a climate analysis tool which features comprehensive projections for different regions of the UK. General climate change trends projected over UK land for the 21st century show an increased chance of warmer, wetter winters and hotter, drier summers along with an increase in the frequency and intensity of weather extremes. This is seen in the Probabilistic (25 km), Global (60 km), Regional (12 km) and Local (2.2 km) projections.

10.5.60 Warmer and wetter winters suggest less snow and more rain. This will create increased risk for flood events, and issues with water quality as less precipitation will be held in its frozen state during the winter season. If climate predictions are correct, summer months will become drier. This will create pressure on the needs of water abstractions and on sensitive ecosystems that rely on aquatic habitats. Evidence also suggests that although the summer months will have an average decrease in rainfall, summer storms will be more frequent and intense. This may lead to more extreme flow values during and immediately following such events, with consequential flooding and water quality issues. This is of key importance for the hydrological environment during summer construction periods.

10.5.61 Increased temperatures in the summer could also increase evapotranspiration and potentially cause desiccation of peat and peat dominant soils. The desiccation could result in the peat being more susceptible to erosion due to increased intensity in summer storms and increased rainfall during the winter months. As peat and peat dominant soils are composed of vegetation remains, they contain a high proportion of carbon compared to other soils.

10.6 RECEPTOR SENSITIVITY

10.6.1 On the basis of the baseline surveys and available information, Table 10.15 presents the sensitivity of the identified receptors based on the criteria outlined earlier in Table 10.2.

[15]Met Office (2020) UK Climate Projections (UKCP) https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index [Accessed 05/08/2022]

Table 10.15: Justification for receptor sensitivity classification

Receptor	Sensitivity	Justification
Designated Sites		
Eglwys Nunydd Reservoir	High	SSSI - designated for its large number of wintering waterfowl and passage migrants. Although not part of the designation, unlikely but potential groundwater linkage could cause detriment to site amenity.
Bryn Tip	High	LNR – designated to protect its historic colliery spoil status and enhance the natural habitat which is home to a number of rare and protected species. Although not part of the designation, potential groundwater linkage could cause detriment to site amenity.
Surface Water		
River Avan/Afon Afan	Medium	Classified under RBMP as having “moderate” overall status upstream of Pelenna River, and “Good” overall status downstream of Pelenna River. Watercourses of high status are of national importance in achieving good water quality status targets. Includes tributary Nant Cynon which has a large catchment with proposed infrastructure situated in headwaters.
Ffrwd Wyllt	High	Classified under RBMP as having “moderate” overall status, this watercourse encompasses the greatest catchment area of Y Bryn Wind Farm. Includes tributaries: Nant Drysiog (proposed infrastructure from north section; passes through Bryn Tip LNR), Nant-y-boda (proposed infrastructure from south section), Nant Cwmwernderi (proposed infrastructure from south section; Cwmwernderi Reservoir), and Nant Cym-y-garn (proposed infrastructure from south section).
Afon Cynffig	Low	Not classified under RBMP, this watercourse encompasses very little proposed infrastructure within its catchment. Includes tributary Nant Cwmcaetreharn (proposed infrastructure from south section).
Arnallt Brook	Medium	Not classified under RBMP with very little proposed infrastructure within its catchment. However, it does contain the Brombil Reservoir on its course which is a privately owned reservoir and local attraction with walkers.
Llynfi River / Afon Llynfi	Medium	Classified under RBMP as having “moderate” overall status upstream of Lletty Brongu STW, this watercourse is responsible for draining only a small percentage of Y Bryn Wind Farm.
Flood Risk		
The proposed development	Low	Only very limited areas of the Y Bryn Site Boundary fall within the flood risk area (i.e., riparian zone of Cwm Wernderi, small topographic hollows, and the functional floodplains associated with the Cwmwernderi Reservoir).
Watercourses downstream of the proposed development	Medium	Downstream watercourses are at potential risk of flooding and any changes to the hydrological environment that results in additional flow could exacerbate the likelihood of flooding. The addition of the proposed development infrastructure will not significantly alter the existing baseline hydrological regime and is likely to have a minimal effect on the existing rainfall-runoff scenario. NFM within Y Bryn Site Boundary to reduce flood likelihood.
Water Resources		
Private Water Supplies	High	Private Water Supplies are of low regional importance, but high in a local context from the perspective of the water supply user.
Cwmwernderi Reservoir	Medium	Owned by Dŵr Cymru, part of the Ffrwd Wyllt catchment. A local recreational amenity attraction.
Eglwys Nunydd Reservoir	High	SSSI - designated for its large number of wintering waterfowl and passage migrants. Although not part of the designation unlikely but potential groundwater linkage could cause detriment to site amenity.
Soils & Peat		
Site soils <0.3 m depth	Low	Site soils are generally <0.3 m deep and therefore are classified as peat soils. In addition, soils are modified by forestry activities and are of local significance.
Site soils and peat ≥0.3 m depth	Medium	Some small areas identified as peat ≥0.3 m depth are considered to be of regional importance.
Hydrogeology		
Underlying Groundwater	Medium	The majority of the site is underlain by a moderately productive aquifer with moderate yields from sandstones and springs. Groundwater has an overall classification of ‘poor’ under RBMP.

10.7 MITIGATION METHODS

10.7.1 Existing tracks have been utilised where practicable and possible. Typically, the construction phase will involve a period of earthworks inclusive of track construction and excavations for forming turbine bases. Following this, the turbine bases and infrastructure will be installed and finally the turbines will be transported to site and erected.

Mitigation by Design

10.7.2 The distribution of the proposed infrastructure has evolved as additional site specific information on peat and water resources became available through consultation and on-site survey works. Hydrological receptors and peat soils were identified as key constraints from the outset, and the design has evolved to minimise impacts on these receptors as far as possible. The proposed development will introduce physical changes which have the potential to alter hydrological characteristics of the site catchments. During the construction phase and to a lesser extent during the operational phase, potential sources of pollution will be present. Hydrological surveys have been undertaken to establish the existing on-site baseline conditions and associated areas downstream, to assess the

potential effect of the proposed development on the identified receptors, the significance of these effects and the potential for mitigation to reduce the significance of the identified effects.

10.7.3 A summary of the hydrological influences on the layout is given with full details of the project design evolution provided in Chapter 4 Site Selection and Design Evolution of the ES. Due to the nature of the environment occupied by the proposed development it is important that the design and infrastructure helps maintain or even enhance the local hydrology. Poor design of development infrastructure can result in significant implications to the hydrological environment with secondary effects on soils and ecology.

10.7.4 The findings of the peat depth survey (Section 10.5 Soils and Peat, and Figure 10.4) show that the infrastructure has, as far as possible, when considering other environmental and engineering constraints, been sited outside areas of peaty soils (≥ 0.3 m). Turbine 9 is the only turbines located on peaty soils >0.3 m (Table 10.13). Peat depths across the rest of the survey area are predominately shallow (<0.3 m) with an average site wide peat depth of 0.2 m.

10.7.5 To facilitate the reduction of potential impacts on the hydrological environment. a series of set-back distances have been adopted and have been designed proportionately to allow greater protection in more sensitive areas:

- All watercourses shown on a 1:25,000 and 1:50,000 scale Ordnance Survey (OS) map were allocated a 50 m buffer from turbines and other new infrastructure, except where necessary.

10.7.6 Other embedded mitigation integrated as part of the design of the proposed development is as follows:

- Borrow pits and their search areas associated with the proposed development, have been located across the site to minimise transportation movements of stone. They are located close to the proposed infrastructure and will be restored after use. All of the proposed borrow pits and search areas are located over 50 m away from watercourses marked on a 1:50,000 scale OS map. Further details are provided in Appendix 10.3: Borrow Pit Assessment.
- The layout of new tracks has been designed to minimise impacts on the hydrological environment and as far as possible avoid sensitive receptors such as watercourses and deeper peat soils. Where required, track widening works will also aim to avoid identified receptors and where unavoidable, widening works will be favoured to progress on the far side of the track i.e., the side with the shallowest peat depth and the opposite side from PWS abstractions.
- The construction compound, substation and met mast have been located to avoid deeper soils and to minimise impacts on the hydrological environment as far as possible.
- One new watercourse crossing will be required for the proposed development where there is no existing track (Appendix 10.1: Water Crossing Assessment). Where possible, existing crossings have been utilised in order to minimise the impact of disturbance on the hydrological environment. The number of new and existing watercourse crossings required is thirteen in total. There are a high number of ridges and furrows across the north and south sections but there are a low number of artificial ditches. As part of the construction program, as well as habitat and flood alleviation proposals, it is envisaged that some of these artificial ditches would be blocked to provide biodiversity enhancement. This is discussed in Appendix 6.3. Habitat Management Plan.
- The majority of the proposed development sits within the catchment of the Ffrwd Wyllt and the River Avan/Afon Afan, which are susceptible to flooding downstream. Through careful design of the supporting drainage, any required watercourse crossing upgrades and the implementation of good management practices, it is envisaged that the potential risk of increased flooding to downstream areas can be effectively mitigated.

Standard Good Practice Mitigation

10.7.7 A number of planning, design and construction proposals have been identified during the assessment. Full details of the good practice construction management and mitigation measures to be implemented will be outlined in a site specific CEMP which would be prepared post consent as part of the conditions discharge process. A summary of the measures which are likely to be included in the CEMP are presented in this chapter and have been assumed to be part of the proposals when the residual effects and their significance are reported.

10.7.8 Some of the mitigation measures described in the following paragraphs can also be adopted during the operational phase of the proposed development.

Outline Construction and Environment Management Plan

10.7.9 A detailed CEMP will facilitate the implementation of industry good practice measures in such a manner as to prevent or minimise effects on the surface and groundwater environment. The CEMP will include information including detailed design details provided by the appointed contractor and agreed with relevant consultees on:

- Drainage – all runoff derived from construction activities and site infrastructure will not be allowed to directly enter the natural drainage network. All runoff will be adequately treated via a suitably designed drainage scheme with appropriate sediment and pollution management measures. The proposed development is situated in an upland forested hydrological area, and it is imperative that the drainage infrastructure is designed to accommodate storm flows based on a 1 in 200-year event plus climate change to help maintain the existing hydrological regime. Drainage management will be agreed with both NRW as consultee and regulator and NPTCBC and BCBC as part of their role as SAB;
- Storage – all equipment, materials and chemicals will be stored well away from any watercourses. Chemical, fuel and oil stores will be sited on impervious bases with a secured bund at a designated location (likely to be construction compound);
- Vehicles and Refuelling – standing machinery will have drip trays placed underneath to prevent oil and fuel leaks causing pollution. Where practicable, refuelling of vehicles and machinery will be carried out in designated areas, on an impermeable surface, and well away from any watercourse. Where avoidable refuelling will not occur in the Nant Cwmwernderi catchment, owing to its limited length and the discharge location into the Cwmwernderi Reservoir, or the Nant Drysiog catchment owing to its proximity to Bryn Tip LNR;
- Maintenance – maintenance to construction plant will be carried out in designated zones, on an impermeable surface well away from any watercourse or drainage, unless vehicles have broken down necessitating maintenance at the point of breakdown, where special precautions will be taken;
- Welfare Facilities – on-site welfare facilities will be adequately designed and maintained to allow the appropriate disposal of sewage. This is likely to be tankered off-site for disposal.. Methods would be confirmed by the appointed contractor post consent and any relevant permits would be applied for prior to construction commencing;
- Cement and Concrete – fresh concrete and cement are very alkaline and corrosive and can be lethal to aquatic life. The use of wet concrete in and around watercourses will be avoided and carefully controlled through implementation of the buffer zones where applicable and good practice construction methods;
- Demarcation – where potentially sensitive receptors have been identified in areas proximal to proposed infrastructure, such as PWS, demarcation on the ground as well as within constraints plans will be undertaken to facilitate their protection;
- Monitoring Plan – all activities undertaken as part of the proposed development will be monitored throughout the construction phase to monitor environmental compliance. Water quality monitoring, including PWS if required will also occur throughout each phase of the proposed development and will help to maximise the effectiveness of embedded mitigation measures whilst monitoring effects on the hydrological environment;
- Contingency Plans – a pollution prevention plan will be prepared and will be implemented to allow plans to be put in place to manage spills or other pollution incidents. The plans will ensure that emergency equipment is

available on site i.e., spill kits and absorbent materials, advice on action to be taken and who should be informed in the event of a pollution incident; and

- Training – All relevant staff personnel will be trained in both normal operating and emergency procedures and be made aware of highly sensitive areas on site.

10.7.10 Further details regarding the pollution prevention and mitigation measures that will be adopted during the construction and operation of the proposed development are detailed in the following paragraphs.

Runoff and Sediment Management

10.7.11 The following measures will be adopted to appropriately attenuate and treat runoff during the construction and operation of the proposed development.

10.7.12 The material used during construction of the proposed development, particularly for access track upgrades and dressing will be carefully considered. This is important to prevent degradation of the track, particularly during construction when there is a high volume of vehicle movements which can result in increased sediment generation if the construction materials are not fit for purpose. Further detail would be provided during detailed design.

10.7.13 The proposed development drainage system will convey water away from construction activities and built infrastructure, however, due to the nature of the works at the proposed development, the steepness of the slopes and the low infiltration and storage capacity of the underlying peat soils and bedrock, there is significant potential for sediment and other pollutants to become entrained in the surface runoff. To reduce this potential, prior to the commencement of and during construction, plans showing site drainage and hydrologically sensitive areas (watercourse buffers, PWS abstraction source and properties) will be designed, constructed and regularly checked to review potential for runoff and ponding of water within the proposed development so that that runoff patterns are well known.

10.7.14 The drainage systems installed within the proposed development will incorporate the principles of SuDS and have sediment management measures incorporated into their design to help reduce or wholly mitigate effects on the hydrological environment. The type of sediment management will depend on the volume of construction activities occurring in particular areas within the proposed development. For all of the suggested control measures, regular inspection and maintenance is necessary, particularly after prolonged heavy rainfall.

10.7.15 Silt traps can be installed within the proposed development drainage system as one element of sediment treatment but should not be relied upon and treatment such as cut off ditches catch pits and lagoons are preferred treatment methods. Where used as part of a wider treatment regime silt traps could take the form of terram fences or clean stone, however, the ability of the silt traps to successfully treat runoff will be dependent upon the permeability of the terram geotextile material and the size and source of the clean stone. If required, flocculants could also be used to treat runoff. Flocculants are very effective at removing suspended sediment from water, but they can also have effects on water chemistry and would not be authorise by NRW until all other methods of treatment have been pursued and exhausted. As such, any requirement for flocculent application would be discussed and explicitly agreed with NRW prior to use.

10.7.16 It is also envisaged that NFM measures embedded as part of the Habitat Management Plan (HMP), including ditch blocking, would facilitate a reduction in surface runoff rates. This would not only help to attenuate peak flows but also enable the gradual release of water, providing a source of long term storage to sustain rivers during periods of low flow. Any NFM measures would be discussed with and agreed by NRW's Neath Port Talbot Environment Team to ensure both compliance with regulation and to tie in / enhance any existing schemes.

Pumping and Dewatering of Excavations

10.7.17 All pumping operations e.g., removal of water from turbine base excavations, will be carried out in line with good practice and, if required, in line with the necessary permits required by NRW. Suitable measures to minimise the impact of the pumped water on the hydrological environment shall be taken.

10.7.18 Due to the expected low permeability of soils (clay rich) across the majority of the proposed development it is expected that the potential for groundwater ingress would be low. However, there remains the possibility for groundwater ingress at the interface between soil/peat layers and the substrate layer as well as through potential sub-surface features. The time that excavations are open will be kept to a minimum to prevent water ingress, as well as secondary impacts on up-slope soils/peat due to dewatering upslope. The ingress of surface water into the excavations will be minimised through the use of up gradient drainage measures e.g., cut-off ditches that will also prevent shallow throughflow entering excavations. It is recognised that water can still enter the excavation and would need to be removed. This can be achieved by allowing the water to gravity drain to a designated area before being pumped from the excavation to a predesigned settlement lagoon or other suitable silt treatment area. The settlement lagoons would be, subject to ground conditions, located as close to the excavation as possible and would attenuate and treat runoff before discharging back into the natural drainage network, mimicking natural flow patterns as far as possible. Given the presence of clay it is possible that fine material/silt will take a long time to settle within the lagoons, as such if required the use of a chemical dosing system would be discussed and authorised by NRW prior to use.

10.7.19 Owing to the peaty and clay rich soils on site, the throughput rate of runoff within the settlement treatment areas would be reduced to give longer settlement time within the excavations and settlement tanks. If required, a series of settlement lagoons or other silt treatment measures can be deployed to allow maximum settlement of sediment during the construction period.

10.7.20 The treated water from the settlement lagoons or other silt treatment measures will not be discharged directly into watercourses but directed onto vegetated surfaces where appropriate. Sediment will be removed from site and the treated water will be deposited amongst the rough surface vegetation, away from sensitive habitats or watercourses.

10.7.21 To reduce the likelihood of erosion channels being formed by the discharge from the sediment treatment outfalls it is recommended that the water is discharged at a slow rate or spread evenly across a surface. For discharge onto rough vegetation to be effective the discharge must be spread efficiently, and the vegetation, soils and topography be carefully considered to determine an appropriate discharge location. For example, filtering the water through a length of pipe with multiple discharge points will allow attenuation as well as diffuse dispersion, thus reducing the erosive potential of the runoff.

10.7.22 The discharge can also utilise silt traps, silt fencing or other attenuation measures. The utilisation of such measures could help to prevent the formation of erosion channels.

10.7.23 To maximise the efficiency of the settlement measures e.g., Siltbusters or other holding lagoons or tanks, the sediment sludge that collects at the base will be removed as required.

Storage of Fuels/Chemicals and Bund Arrangements

10.7.24 Throughout construction, and to a lesser extent during the operational phase of the proposed development, a number of oils and chemicals will be used. Such materials will be used and stored in compliance with Control of Substances Hazardous to Health (COSHH) requirements at the construction compounds.

10.7.25 The following measures will be adopted to protect the surface and groundwater environment from the inappropriate storage and use of substances hazardous to the environment:

- All equipment, materials and chemicals to be stored away from any watercourses. Chemicals, fuel and oil will be stored in tanks of sufficient strength and structural integrity to reduce the chances of bursting or leaking in ordinary use. They will also be sited on impervious bases within a secured bund of 110% of the storage capacity;
- Where oil is stored in a bunded area, oil residue can build up. This residue build-up will reduce the storage capacity of the bund and will be removed regularly. The residue will be disposed of by a specialist contractor;
- Locks shall be fitted to all fuel storage tanks or containers and there shall be a nominated trained person to oversee the refuelling and delivery to minimise the risk of spillage; and
- Standing machinery to have drip trays placed underneath to prevent oil and fuel leaks causing pollution. Where practicable refuelling of vehicles and machinery will be carried out at central designated areas, on an impermeable surface, which will be located at least 50 m away from any watercourses.

Refuelling

10.7.26 External fuel delivery lorries will only be allowed as far as the relevant site compound where there will be a bunded refuelling/fuel storage area constructed on an impervious base. Delivery lorries will transfer fuel to the on-site fuel tank or truck located within the bunded refuelling area to minimise the amount of fuel being driven around the proposed development and minimise external drivers accessing the proposed development.

10.7.27 A designated fuel truck/bowser will be used for refuelling in designated refuelling areas. The bowser driver will receive extra training on spill prevention and response.

10.7.28 The refuelling area shall be equipped with a mobile spillage control kit containing oil absorbent booms and mats. Nominated personnel will be trained and responsible for refuelling. Other personnel will also be trained on spill response as part of the proposed development induction training or toolbox talks. Special attention will be paid to spillage control at/near watercourses.

Vehicle Maintenance and Management

10.7.29 All plant used during the construction of the proposed development will be in suitable condition and fit for purpose to carry out the works and will be maintained as per manufacturers guidelines.

10.7.30 Maintenance of construction plant to be carried out only in designated areas, on an impermeable surface away from any watercourse or drainage. Only if vehicles have broken down will maintenance be permitted outside of a designated area, and this would only be carried out after implementing special precautions. Such precautions include, but are not limited to:

- Ensure that drip trays are placed underneath vehicles during maintenance;
- As a precautionary measure, and if deemed appropriate, straw bales, booms or entrapment matting would be placed downstream of the maintenance area;
- All heavy construction plant will be inspected daily by the operating personnel and any defects or issues resolved immediately prior to starting works. All heavy construction plant shall be issued with spill kits. Should a spillage occur, larger spill kits shall also be positioned at various areas within the proposed development which will be highlighted to all operatives during the site induction; and
- Standing machinery and plant will have industry standard drip trays (or similar, e.g., plant nappies – open metal drip trays are not permitted) placed underneath to prevent oil and fuel leaks causing pollution.

Concrete Works

10.7.31 Concrete would be required for the construction of the wind turbine and met mast foundations and foundations for the substation/control room buildings. The following section provides best practice measures that are required to be implemented to prevent detrimental effects to the hydrological environment.

10.7.32 Care will be taken during the transportation of concrete to the turbine and building foundations and will be carried out following good practice measures. Freshly mixed concrete and/or dry cement powder will not be allowed to enter any watercourse. This will be avoided by:

- Locating turbines, concrete batching or wash out areas as far as practical from watercourses;
- Concrete wagons will only be permitted to wash-out into specifically designed wash-out areas at predetermined and agreed locations site wide;
- The drivers will be informed at their site induction of the location of the designated wash-out areas and issued with a location map;
- Loads will be managed and assessed with regards to the size of vehicle and ground conditions whilst keeping at appropriate speed limits to avoid spillage;
- Tools and equipment will not be cleaned in watercourses. Should it be necessary to clean tools and equipment on site, this will be done in the predetermined wash-out areas;
- A designated concrete wash-out area will be constructed within the proposed development at a location agreed with the relevant consultees to protect watercourses. The design and construction of these wash out areas will be agreed with consultees post consent; and
- Wash out areas will be continually monitored, and findings recorded to reduce the chances of effluent spilling over into the environment.

10.7.33 It is imperative that concrete wash water and concrete waste is properly disposed of and the details for this would be provided by the appointed contractor post consent in advance of construction commencing. Any relevant permits would be applied for from NRW.

Site Drainage

10.7.34 Full details on the site drainage would be provided post consent and subject to detailed engineering design and finalised layout. To facilitate this design, the following section discusses the standard site drainage measures that would, in some form, be installed during the construction and operation of the proposed development.

10.7.35 Surface drainage ditches will be installed alongside tracks only where necessary. The length, depth and gradient of individual drains will be minimised to avoid intercepting large volumes of diffuse overland flow and generating high velocity flows during storm events. Sediment traps, settlement ponds and buffer strips will be incorporated into the drainage system as necessary and will serve the dual purpose of attenuating peak flows, by slowing the flow of runoff through the drainage system and allowing sediment to settle before water is discharged from the drainage system.

10.7.36 As well as utilising sediment traps, structures such as check dams will be installed within the drainage channels. Such structures will throttle the flow within the channel, thus reducing erosive potential of any runoff and allowing sediment and/or pollutants to settle.

10.7.37 To reduce the impact of the proposed development on the natural hydrological regime, the site drainage will mimic greenfield runoff response through the use of sustainable drainage practices.

10.7.38 SuDs will be taken into consideration as part of the water management plan and details of the proposed SuDs regime would be included in the detailed CEMP and to meet the requirements of the SAB. The statutory guidance[16] will be followed, specifically the requirements of the six standards:

- S1 – Runoff Destination;
- S2 - Hydraulic Control;
- S3 - Water Quality;
- S4 – Amenity;
- S5 – Biodiversity; and
- S6 – Construction, Operation and Maintenance.

10.7.39 SuDs are used to attenuate rates of runoff from development sites and can also have water purification benefits. The implementation of SuDs as opposed to conventional drainage systems provides several benefits by:

- Reducing peak flows to watercourses and potentially reducing risk of flooding downstream;
- Reducing the volumes and frequency of water flowing directly to watercourses;
- Improving water quality by removing pollutants;
- Reducing potable water demand through rainwater harvesting; and
- Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

10.7.40 Whilst it is understood that the scope for traditional SuDs measures is limited by the hydrological environment and topographic setting of the proposed development, the adoption of the principles mentioned in designing the drainage across the site will maintain greenfield runoff rates.

10.7.41 Access tracks crossing slopes will disrupt surface flow that consequently will collect in drains constructed upslope of the tracks. Cross-drains and/or water bars will be constructed at regular intervals to conduct this surface flow below or across the track where it will be discharged back into the drainage system. All efforts will be made to segregate this runoff from more-silty runoff originating from track surfaces and other exposed construction areas, thus reducing the silt load and volume discharging to all silt treatment areas. Regular discharge points will limit the concentration of surface runoff and the diversion of flows between catchments. Such cross drains need to be strong enough to withstand the expected traffic loadings.

10.7.42 During storm events there is the possibility for ponding on the uphill side of tracks, as percolation alone is unlikely to be able to accommodate surface flows. To minimise this ponding, small diameter cross drains or twinwall culverts would be incorporated into the track base at regular intervals to allow more flow to pass through the track and maintain the current flow regime. It is recommended that such pipes are surrounded by free draining material that is wrapped in a separator geotextile. The number of pipes and associated dimensions will be dependent upon the width of the flush/boggy area and the hydrological regime.

10.7.43 Prior to track construction, site operatives will identify flush areas, depressions or zones which may concentrate water flow. These sections will be spanned with plastic pipes to help maintain hydraulic conductivity under the road and reduce water flow over the road surface during heavy precipitation.

10.7.44 Due to the poor permeability of the surrounding clay and peaty soils and bedrock, it is also recommended that drains and/or cut-off drains are installed on the upstream/upgradient sides of the turbine foundations, crane hardstands, and other excavations required across the proposed development. The purpose of this will be to help reduce the volume of surface water runoff entering the excavations and minimise any subsequent contamination.

10.7.45 The constructed drainage system will not discharge directly to any natural watercourse or groundwater, but will discharge to buffer strips, trenches or SuDS measures, preferably on flatter, lower lying ground. These buffers will act as filters and will minimise sediment transport, attenuate flows prior to discharge and maximise infiltration of water back into the soils and peat.

10.7.46 Drainage from the construction compounds, welfare facilities, borrow pits and concrete wash out areas will be collected and treated separately from the main site drainage, as the runoff from these areas is more likely to be contaminated and therefore will require treatment. Appropriate treatment, such as oil interceptors and treatment for high alkalinity, will be installed.

10.7.47 Mitigation will follow industry good practice. All mitigation and drainage will be subject to detailed design and approved by NRW prior to construction with the Environmental Clerk of Works (ECoW) ensuring compliance.

10.7.48 One new watercourse crossing will be required, along with upgrading of some of the existing watercourse crossings, as part of the access tracks associated with the proposed development (see Appendix 10.1: Watercourse Crossing Assessment). The crossings will be appropriately designed so that they do not alter the natural drainage, hinder the passage of aquatic fauna and can accommodate flow at a minimum of 1:100yr + allowance for climate change event. All watercourse crossings will be designed with edge upstands or bunds e.g., booms, sandbags or silt fences to prevent sediment laden runoff from construction plant movement from directly entering watercourses. Relevant authorisation will be sought from the NPTCBC as the Lead Flood Authority for construction of the watercourse crossings.

Welfare Facilities/Foul Water

10.7.49 The following measures will be adopted for the design of the foul water drainage system:

- Any sewage associated with the temporary construction compounds, substation and welfare facilities will be collected in appropriately sized interceptor tanks and shall be located at the construction compounds. All wash basins, toilets and shower areas shall also be connected to an interceptor tank;
- The interceptor tanks and the tanks within any site portable toilets, which shall be situated not less than 50 m from any watercourse, will be emptied regularly by a suitably licensed contractor. The final location will be in agreement with NRW; and
- Sewerage from these facilities will be disposed offsite in accordance with waste management legislation.

Emergency Water Management Measures

10.7.50 A significant volume of oils and chemicals will be stored on site during the construction phase and to a lesser extent the operational phase. Site traffic will also be present in significant numbers during the construction phase of the proposed development, with traffic volumes significantly reduced during wind farm operation.

10.7.51 The appropriate storage of oils, chemicals and maintenance of site plant has been discussed in the preceding paragraphs. However, despite these measures, accidents can happen, and these can have significant impacts upon the quality of the surface and groundwater environment. The following emergency procedures can be implemented to provide additional protection to the surface and groundwater environment during wind farm construction and operation:

- All relevant on-site staff to be trained in both normal operating and emergency procedures and be made aware of highly sensitive areas on site. The staff training and implementation of site procedures will be overseen by the infrastructure contractor so that these measures are carried out effectively to minimise the risk of a pollution incident;

[16] Welsh Government (2019) Sustainable Drainage (SuDS) Statutory Guidance, [Online] Available from statutory-guidance.pdf (gov.wales) [Accessed 05/08/2022]

- Contingency plans will be designed that clearly highlights the location of emergency equipment available on site (i.e., spill kits and absorbent materials), training on correct use and that advice is provided on actions to be taken and who would be informed, in the event of a pollution incident;
- Contingency planning procedures must be regularly reviewed to include changes to site operations that were not foreseen during design;
- The procedures set out in site contingency plans need to be prepared in conjunction with the assessment of the risk of a pollution incident occurring and the measures to be taken to minimise pollution. The location of the procedures will be publicised, and it is essential that they are set out clearly so that they can easily be understood and acted upon; and
- The emergency procedures can include the following:
  - Containment measures;
  - Emergency discharge routes;
  - List of appropriate equipment and clean-up materials;
  - Maintenance schedule for equipment;
  - Details of trained staff, location, and provision for 24-hour cover;
  - Details of staff responsibilities;
  - Notification procedures to inform the relevant environment protection authority;
  - Audit and review schedule;
  - Telephone numbers of statutory and local water company; and
  - List of specialist pollution clean-up companies and their telephone numbers.

Soil Handling and Storage

10.7.52 The construction of roads, turbine foundations, crane hardstanding areas, construction compounds and substation, as well as the establishment of borrow pits will require the stripping of surface soils / peat soils and its temporary storage. The following paragraphs present the mitigation measures required to minimise impact on underlying soils/peat and peaty soils.

10.7.53 Topsoil will be stripped keeping some intact. Turves will be stripped and handled with care and kept vegetation side up such that damage to the living vegetation mat is prevented or minimised as far as possible.

10.7.54 This material will be stored upright adjacent to the working area but sited away from watercourses and drains, as far as is practicable. Surface water would ideally be directed away from construction activity to avoid silty run off entering watercourses or ecologically sensitive areas. The stored mounds will be limited in height to 1.5 m to minimise the risk of instability and compaction of lower layers. Subsoil and peaty soil that is stripped and stored will be kept separate from the topsoil.

10.7.55 The excavation of soils is to be undertaken in such a manner as to avoid cross contamination between distinct horizons. The different soil horizons will be kept and stored separately for use at a later date.

10.7.56 During and after excavation, the storage, haulage and reuse of excavated material will be planned in advance to minimise material movement around the site. Immediate reuse is preferred to temporary storage (where possible). Further details are provided in the following paragraphs.

10.7.57 Turves will be stripped and handled with care and kept vegetation side up such that damage to the living vegetation mat is prevented or minimised as far as possible.

10.7.58 The following will also be considered in the handling and storage of excavated soils:

- Sediment Discharges – implementation of a buffer zone to minimise impacts to watercourses and water supplies, undertaking of water quality monitoring particularly after heavy rainfall, and assurance that culverts or bridging of watercourses are of sufficient size and spacing with appropriate erosion mitigation measures; and
- Contaminant discharges – follow GPPs and PPGs, refuel and store oils and fuels in designated areas.

10.7.59 Further details on the measures to appropriately manage the excavation, storage and reinstatement of excavated material is provided in the following paragraphs.

Excavation

10.7.60 Prior to any excavation, detailed method statements will be produced identifying where and how excavated soil and peat will be used in reinstatement or landscaping works. Specific requirements for the excavation, handling, storage and reinstatement of soil will be outlined in the above method statement. The method statements will consider peat layering and the potential impacts on downstream hydrological receptors and the potential for instability issues with the excavated material.

10.7.61 The principal requirements are outlined:

- All excavations where required should be monitored and measures taken to prevent collapse and the destabilising of soil deposits adjacent to excavations;
- A system of daily reporting of excavations will be established during construction and utilised to monitor the geotechnical performance of slopes including sub-soil and bedrock. This would be implemented and undertaken by a suitable, experienced and trained member of the site team;
- Excavated turves should be as intact as possible. Turves will be stored vegetation side up to promote the retention of structure prior to use in reinstatement; and
- Care will be taken when stripping and removing topsoil and peaty turves and appropriate storage methods will be used on site, i.e., excavated material will be stored in separate horizons with turves being placed on top of excavated material to minimise desiccation and oxidisation. They would be placed in a manner to maximise coverage in a ‘checkerboard’ pattern.

Temporary Storage of Excavated Material

10.7.62 Excavated material that is stockpiled on site for further use should be managed to prevent silty run-off or losses due to drying out and wind. The temporary storage of excavated material shall seek to minimise the disturbance of soil/peaty soil deposits through minimising haul distance between temporary storage sites.

10.7.63 The suitability of temporary storage areas will be confirmed prior to works taking place and the following key control measures will be considered:

- Topsoil and peaty soil will be stripped and stored separately within the pre-identified areas to maximise the success of safe storage and swift and successful reinstatement;
- If space does not allow storage and the surplus is to be stored elsewhere on the site, the ECoW will be consulted in advance to agree appropriate areas;
- Separate areas will be created for the different layers and topsoil will not be mixed with subsoil layers;
- Stacked topsoil will not exceed a height that enables the topsoil to breakdown. The maximum height for stacked material will be agreed in advance with a maximum height likely to be 1.5 m;
- Storage areas will be located away from watercourses (minimum of 50 m, where practical) protected from run-off from adjacent areas;
- Storage areas should be reinstated to their original condition on completion of their use for storage;

- If soil storage is being carried out on sensitive habitats, consideration will be given to storage on top of a geotextile mat and storage duration shall be minimised;
- Good practice will be adopted in order to minimise the amount of compaction or other disturbance of the general structure of the superficial deposits;
- Other site works will not impact on stored soil (e.g., construction traffic will not track over stored soils);
- If significant soil erosion is occurring from storage piles during periods of heavy rain action will be taken to cover the stockpiles, where practical. The silt fencing or other mitigation around the base of the stockpile will be monitored and replaced as necessary;
- In periods of dry weather check the need for watering to reduce dust and potential nuisance;
- A silt fence will be constructed at the base of the stockpile using a suitable geotextile if required;
- Construct drainage channels to direct surface water away from stockpiles and prevent erosion at the base; and
- Construct drainage channels to direct water through settlement ponds.

Site Reinstatement

10.7.64 So far as is reasonably practicable, all disturbed areas which require reinstatement will be reinstated with the same vegetation types as exist at present, thereby ensuring minimum disruption to the surrounding landscape. Preference would always be to reinstate using natural site won materials.

10.7.65 The reinstatement and storage of any excavated materials will involve replacement of previously stripped soils, vegetated layers or turves. Timing of reinstatement works will also consider adjacent construction activities which may disturb any reinstatement works already carried out.

10.7.66 Stripped turves are likely to degrade and become unsuitable for use in reinstatement if stored for prolonged periods of time. Therefore, the amount of time between the construction activities and subsequent reinstatement will be minimised as much as practically possible.

10.7.67 The fundamental aspects of reinstatement are summarised as follows:

- Stripped soil will be reinstated, including landscaping of infrastructure verges, as close to where it was removed as possible. This will help to maintain a local seed base and the local geological/hydrological characteristics;
- Subsoil, topsoil and turfs replaced in same order as removed;
- During periods of dry weather, exposed soils shall be kept moist;
- Unless otherwise agreed, turfs will be reinstated following the works and orientated vegetation side up;
- Reinstatement will be carried out as soon as is possible following stripping to ensure integrity of material is maintained;
- Where turfs are not available, areas will be left to re-vegetate naturally. If there is not sufficient turf to completely cover an area, then turf will be spread in smaller sections to offer some protection and spread the seed bank rather than leave larger exposed areas;
- Any soil found to be contaminated will not be used for reinstatement but disposed of off-site to a licensed or exempted facility, if necessary; and
- The reinstatement of the construction areas will be undertaken to a high standard, using the existing soil and vegetation material wherever possible, in accordance with industry good practice.

Additional Mitigation

10.7.68 Where specific risks exist for individual receptors as a result of the construction and operation of the proposed development, additional mitigation will also be used alongside embedded mitigation to further reduce measurable impacts. The recommendations outlined will be incorporated into the CEMP post-consent.

10.7.69 The use of general site pollution control and other mitigation measures outlined in this chapter apply to the entire area of the proposed development. The Ffrwd Wyllt catchment including Nant Drysiog sub catchment as identified in Table 10.15 are more sensitive than other watercourses to environmental impacts and downstream flooding. Mitigation, including the use of SuDs, NFM and sediment management which will also be presented for the wider proposed development as part of the detailed design in the CEMP post consent. The establishment of communication channels for risk management and monitoring will be essential.

10.7.70 NFM measures would be implemented to further reduce downstream flood risk. This would include hydrological modelling as part of the outline and detailed design to determine the likely benefit that the implemented measures would provide on reducing flood risk to the proposed development and areas of flood risk immediately downstream. Following the completion of this assessment and agreement of the proposed NFM measures with all relevant stakeholders (including NRW and local planning authorities), the NFM strategy would be implemented. It is hoped that engagement with the local community would facilitate involvement in both the planning and implementation phases of the NFM strategy. It is anticipated the NFM system would be implemented during the operational phase.

10.7.71 Site-specific mitigation will be undertaken at the relevant private water supplies situated adjacent to or within the Y Bryn Site Boundary This will include the implementation of a series of additional measures which are summarised in Table 10.10 and include, as a minimum:

- Completion of investigations to verify the supply details, including abstraction location and supply delivery infrastructure;
- Completion of further investigations to further characterise the groundwater system;
- Detailed design of drainage system to encourage infiltration of treated and discharged runoff;
- Demarcation of supply and infrastructure and appropriate design of standard good practice mitigation to avoid potential for impact;
- Where necessary provision of alternative temporary or permanent alternative water supply; and
- Establishment of a program of baseline and construction inspection and monitoring.

10.7.72 The above measures will be provided in a detailed Private Water Supply Monitoring Plan and Method Statement (PWSMP) that will be prepared following the completion of the detailed investigations undertaken pre-construction. The implementation of this additional mitigation will be the responsibility of the Developer and nominated Principal Contractor.

10.8 PREDICTED CONSTRUCTION EFFECTS

10.8.1 The potential for effects on the hydrological environment is greatest during the construction phase due to the high levels of activity on-site and when there is greatest change to the existing environment. The potential effects associated with the construction of the proposed development is discussed and assessed in the following sections.

10.8.2 The evaluation of construction effects is provided in Table 10.16. The assessment results are based on the successful implementation of the embedded good practice mitigation measures as well as the additional mitigation measures provided in Section 10.7: Mitigation Methods.

Predicted Construction Effects

Pollution Incidents

10.8.3 During the construction phase, a number of potential pollutants will be present onsite, including oil, fuels, chemicals, unset cement and concrete, waste and wastewater from construction activities and staff welfare facilities. The majority of these potential pollutants will be located or stored within construction compounds in addition, there is the potential for contamination of the hydrological and terrestrial environment caused by spillages along the access tracks, and construction areas.

Erosion and Sedimentation

10.8.4 Soil and sediment generation may occur in areas where the ground has been disturbed, particularly where surface runoff has been concentrated. Drainage ditches are particularly prone to this problem, due to the high velocities of surface water runoff passing through the drainage network. Considerable sediment generation is expected where the ground has been excavated for the proposed development infrastructure.

10.8.5 Sediment transport in watercourses can result in high turbidity levels which can impact on the water quality, particularly affecting the ecological potential of the watercourses. High turbidity in watercourses can reduce the light and oxygen levels in the watercourses, while sediment deposition can smother plant life and spawning grounds. Sediment deposition can also reduce the flood storage capacity of the watercourses and block culverts, resulting in an increased flood risk.

10.8.6 As a result of the construction operations, all catchments with new and upgraded infrastructure present are vulnerable to erosion and sedimentation.

Changes in Water Quality

10.8.7 Excavation and disturbance of soils, subsoils, clay and peat could result in changes in the chemistry of surface water runoff including colour, DOC, turbidity and dissolved metals. As with erosion and sedimentation, this can have implications on both the quality of the aquatic habitat and also the resource potential of the water itself. For the Nant Cwmwernderi catchment, opportunities for mixing, dilution and attenuation before entering the reservoir will be more limited than other watercourses.

10.8.8 Tree removal for construction related purposes could also increase nitrogen mineralisation and nitrification, which can promote nitrate leaching and enhance acidity in waters draining some soils. The effect can last between two to five years after felling, depending upon the rate at which vegetation re-establishes. The filling of trenches with fresh brash could accentuate the effect by promoting leaching below the rooting zone.

10.8.9 Potential pollutants coming into contact with bedrock, or the superficial sediments also have the potential to alter the quality of the groundwater resource. Such alterations including changes in pH or addition of chemicals could be difficult to rectify, and due to the limited extent of any superficial aquifer, would attenuate very slowly.

Increases in Runoff

10.8.10 Turbine bases, hardstand areas and access tracks etc. will act as impermeable areas, restricting the natural movement of water within the hydrological environment, potentially resulting in increased rates of runoff into the onsite and downstream catchments. The pre-construction, construction and permanent site drainage will be designed to mimic greenfield runoff response through the use of sustainable drainage practices.

10.8.11 Localised increases in runoff could cause issues for downstream flood storage capacity and/or pollution incidents. Increases in the volume of runoff entering watercourses could also cause erosion and sedimentation, therefore having detrimental effects on surface water hydrology.

10.8.12 In the areas which are to be felled, localised runoff responses have the potential to increase due to the reduction in precipitation being intercepted by the closed canopy forestry. Felling and extraction would also be planned to minimise the number of drain crossings and reduce any increases in runoff. In addition, sediment management techniques such as use of silt fences would be used in areas of felling as well as construction.

10.8.13 The low permeability of the superficial deposits, particularly clay, within the proposed development area will naturally encourage high rainfall-runoff rates. Therefore, the addition of the proposed development Infrastructure will not significantly alter the existing baseline hydrological regime and is likely to have a minimal effect on the existing rainfall-runoff scenario.

Modification of Surface Drainage Patterns

10.8.14 The interception of diffuse overland flow by the proposed development infrastructure and associated drainage may disrupt the natural drainage regime of the area, concentrating flows and potentially diverting flows from one catchment to another. This may have implications for water quality or quantity (including PWS) and on flood issues downstream of the proposed development.

10.8.15 As well as potentially negative effects, construction may also positively effect surface drainage patterns through the blocking of artificial ditches during habitat restoration and NFM enhancement measures and therefore encouraging the development of a natural rainfall-runoff response.

Impediments to Surface Water Flow

10.8.16 The design and construction of watercourse crossings will be appropriately sized to accommodate the 1 in 200 years + Climate Change flow. Where required, watercourse crossings should allow for the migration of fish and mammal movement in the riparian corridor. However, there remains the risk that drainage channels and culverts can become blocked with debris particularly during periods of heavy and/or prolonged precipitation.

Modification of Groundwater Flows and Levels

10.8.17 Deep excavations, such as those required for the turbine foundations are likely to disrupt the shallow groundwater systems and bedrock geology. Surface water ingress will be minimised by utilising upgradient cut-off drains or other drainage measures. The installation of cut-off drains has the potential to lower local groundwater levels within surrounding peat dominated soils.

10.8.18 The majority of temporary and permanent infrastructure (apart from foundations) would be permeable to some extent.

10.8.19 Access tracks and other linear infrastructure elements such as cable trenches have the potential to disrupt flow pathways as granular backfill may create preferential infiltration and throughflow pathways. These may interrupt shallow groundwater flow or alter the hydrological regime impacting baseflow to watercourses, habitats and PWS.

Assessment of Construction Effects

10.8.20 Table 10.16 identifies the likely construction effects on the identified receptors and their significance assuming the successful implementation of good practice and embedded mitigation measures. A further column has also been provided considering the effect significance upon receptors following the implementation of additional mitigation outlined in paragraphs 10.7.65 – 10.7.69.

Table 10.16: Assessment of construction effects

Potential Effect	Identified Receptor	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation			Additional Mitigation Requirements	Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effect		Sensitivity	Magnitude of Impact	Significance of Effect
Designated Sites								
• Pollution incidents • Erosion and sedimentation • Changes in groundwater Quality	Eglwys Nunydd Reservoir	High	Negligible	Moderate/Minor	None	-	-	-
	Bryn Tip	High	Low	*Moderate*	Additional mitigation through NFM outlined above in paragraphs 10.7.65 – 10.7.67. NFM as detailed in Appendix 6.3: Habitat Management Plan	High	Negligible	Moderate/Minor
Surface Water Quality								
• Pollution incidents • Erosion and sedimentation • Changes in Water Quality • Increase in Run-off • Modifications to Surface Drainage Pattern • Impediments to Surface Water Flow	River Avan/Afon Afan (including tributaries)	Medium	Low	Moderate/Minor	None	-	-	-
	Ffrwd Wyllt (including named tributaries)	High	Low	*Moderate*	Additional mitigation outlined above in paragraphs 10.7.65 – 10.7.67.	High	Negligible	Moderate/Minor
	Afon Cynffig (including named tributary)	Low	Low	Minor	None	-	-	-
	Arnallt Book	Medium	Low	Moderate/Minor	None	-	-	-
	Llynfi River / Afon Llynfi	Medium	Low	Moderate/Minor	None	-	-	-
	Eglwys Nunydd Reservoir	High	Negligible	Moderate/Minor	None	-	-	-
	Cwmwernderi Reservoir	Medium	Low	*Moderate/Minor*	Additional mitigation outlined above in paragraphs 10.7.65 – 10.7.67.	Medium	Negligible	Minor
Flooding								
• Increase in run-off. • Modifications to Surface Drainage Patterns • Impediments to Surface Water Flow • Compaction of Soil	The proposed development	Low	Low	Minor	Additional mitigation outlined above in paragraphs 10.7.65 – 10.7.67. NFM as detailed in Technical Appendix 6.3: Habitat Management Plan	-	-	-
	Watercourses downstream of the proposed development	High	Low	*Moderate*	None	High	Negligible	Moderate/Minor
Water Resources								
• Pollution incidents • Erosion and sedimentation • Changes in Water Quality • Increase in Runoff • Modifications to Surface Drainage Pattern	Cwmwernderi Reservoir	Medium	Low	Moderate/Minor	None	-	-	-
	Private Water Supplies (not hydrologically connected)	High	Negligible	Moderate/Minor	None	-	-	-

Potential Effect	Identified Receptor	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation			Additional Mitigation Requirements	Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effect		Sensitivity	Magnitude of Impact	Significance of Effect
• Impediments to Surface Water Flow • Modification of Groundwater Flows and Levels • Compaction of Soils	Private Water Supplies with potential hydrological connection (Table 10.10) IDs: 4,9,56,57	High	Medium	*Major/Moderate*	Additional mitigation outlined in Table 10.10 including further detailed investigations post consent and paragraph 10.7.68 – 10.7.69	High	Negligible	Moderate/Minor
Soils								
• Pollution incidents	Site soils and peat <0.3 m depth	Low	Low	Minor	None	-	-	-
• Modifications to Surface Drainage Patterns • Modification of Groundwater Flows and Levels • Compaction of Soils	Site soils and peat ≥0.3 m depth	Medium	Low	Moderate/Minor	None	-	-	-
Hydrogeology								
• Pollution incidents	Groundwater within Sub Soils	Medium	Low	Moderate/Minor	None.	-	-	-
• Modification of groundwater flows and levels • Compaction of Soils	Underlying Groundwater	Low	Low	Minor	None.	-	-	-

10.9 PREDICTED OPERATION EFFECTS

10.9.1 The effects of the proposed development will be substantially lower during the operational phase. The following paragraphs discuss and assess the potential effects that are predicted to occur during the operational phase of the proposed development. The assessment of effects assumes the implementation of the good practice mitigation that is outlined above and would be incorporated into a full site-specific CEMP post consent.

Predicted Operation Effects

Pollution Incidents

10.9.2 The potential risk of pollution is substantially lower during operation than during construction because of the reduced levels of activity in the operational phase. Most potential pollutants will have been removed when construction was completed; however, lubricants for turbine gearboxes, and transformer oils may be stored on site (as well as being contained within the equipment themselves) and there is the risk of possible fuel leaks from maintenance vehicles whilst onsite.

Erosion and Sedimentation

10.9.3 Levels of erosion and sedimentation during operation will be much lower than construction as there will be no excavations or bare exposed ground. Some erosion and sedimentation are still possible on the access tracks and drainage ditches as a result of scouring during extreme rainfall events. Similarly, there could be some short term increases to erosion and sedimentation around new or upgraded stream crossings as watercourses reach new equilibrium primarily within the construction and early in the operational phases of the proposed development.

Changes in Water Quality

10.9.4 During the operation phase there will be no continued construction works associated with excavation and exposure of soils, peat and sediments. Opportunities for erosion and transportation of materials will be considerably reduced during the operational phase as previously exposed surfaces become vegetated.

Changes in Runoff Regime

10.9.5 Temporary drainage management features such as silt ponds and silt fencing will be dismantled and the ground reinstated, with retained features designed to blend into the landscape. The retention of permanent drainage management features such as trackside ditches is likely to reduce the rate of runoff compared to the construction phase with permanent drainage designed to mimic greenfield hydrological regimes.

Modification of Surface Drainage Patterns

10.9.6 Modification of surface runoff will occur as a result of the construction of the new infrastructure associated with the proposed development. The operational effects could result in changes to volume and/or changes to runoff rate, however the permanent drainage will be designed to avoid this.

Impediments to Surface Water Flow

10.9.7 During the operational phase impediments to flows can generally occur as a result from blockages to watercourse crossings, ditches and watercourses themselves, resulting from vegetation and erosion debris. The cost of maintaining the mitigation measure shall be met by the operator through the lifetime of the planning permission.

Modification of Groundwater Flows and Levels

10.9.8 Cut tracks and their drainage as well as cable trenches, turbine foundations and hardstands will potentially alter the water table within the upslope and downslope peat and bedrock groundwater, which can also have implications for the long-term functionality of peatland environments.

10.9.9 This impact would be minimal through detailed design of foundations and drainage to encourage groundwater flow and prevent cutting groundwater flow pathways. Peat habitat management and restoration along with site reinstatement would be designed to enhance water table rebound in peat.

Assessment of Predicted Operation Effects

10.9.10 Table 10.17 identifies the likely operational effects on the identified receptors and their significance based on the successful implementation of good practice and embedded mitigation measures. The only additional mitigation during the operational phase will be the permanent mitigation for PWSs and the adoption of NFM enhancement measures as part of long-term flood risk management.

Table 10.17: Assessment of predicted operational effects.

Potential Effect	Identified Receptor	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation			Additional Mitigation Requirements	Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effect		Sensitivity	Magnitude of Impact	Significance of Effect
Designated Sites								
• Pollution incidents • Erosion and sedimentation	Eglwys Nunydd Reservoir	High	Negligible	Moderate/Minor	None	-	-	-
• Changes in groundwater Quality	Bryn Tip	High	Negligible	Moderate/Mi	None	-	-	-
Surface Water Quality								
• Pollution incidents • Erosion and sedimentation	River Avan / Afon Afan (including tributaries)	Medium	Negligible	Minor	None	-	-	-
• Changes in Water Quality • Increase in Run-off	Ffrwd Wyllt (including named tributaries)	High	Negligible	Moderate/Minor	None	-	-	-
• Modifications to Surface Drainage Pattern	Afon Cynffig (including named tributary)	Low	Negligible	Minor/Negligible	None	-	-	-
• Impediments to Surface Water Flow	Arnallt Brook	Medium	Negligible	Minor	None	-	-	-
	Llynfi River / Afon Llynfi	Medium	Negligible	Minor	None	-	-	-
	Eglwys Nunydd Reservoir	High	Negligible	Moderate/Minor	None	-	-	-
	Cwmwernderi Reservoir	Medium	Negligible	Minor	None	-	-	-
Flooding								
• Increase in run-off	The proposed development	Low	Negligible	Minor/Negligible	No mitigation required. However, NFM measures adopted for environmental betterment as detailed in Appendix 6.3	-	-	-
• Modifications to Surface Drainage Patterns • Impediments to Surface Water Flow • Compaction of Soil	Watercourses downstream of the proposed development	High	Negligible	Moderate/Minor		-	-	-
Water Resources								
• Pollution incidents • Erosion and sedimentation	Cwmwernderi Reservoir	Medium	Negligible	Minor	None	-	-	-

Potential Effect	Identified Receptor	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation			Additional Mitigation Requirements	Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effect		Sensitivity	Magnitude of Impact	Significance of Effect
• Changes in Water Quality • Increase in Runoff • Modifications to Surface Drainage Pattern • Impediments to Surface Water Flow • Modification of Groundwater Flows and Levels • Compaction of Soils	Private Water Supplies (not hydrologically connected)	High	Negligible	Moderate/Minor	None	--	--	--
	Private Water Supplies with potential hydrological connection (Table 10.10) IDs: 4,9,56,57	High	Low	*Moderate*	Monitoring might be required at the start of the operational phase this would be confirmed in the PWSMP.	High	Negligible	Moderate/Minor
Soils								
• Pollution incidents • Modifications to Surface Drainage Patterns • Modification of Groundwater Flows and Levels • Compaction of Soils	Site soils and peat <0.3 m depth	Low	Negligible	Minor/Negligible	None	-	-	-
	Site soils and peat ≥0.3 m depth	Medium	Negligible	Minor	None	-	-	-
Hydrogeology								
• Pollution incidents • Modification of groundwater flows and levels • Compaction of Soils	Groundwater within Sub Soils	Medium	Low	Moderate/Minor	None.	-	-	-
	Underlying Groundwater	Low	Low	Minor	None.	-	-	-

10.10 CUMULATIVE EFFECTS INCLUDING NON-WIND

Predicted Cumulative Effects

10.10.1 There is one operational wind farm development immediately adjacent to the proposed development, Mynydd Brombil Wind Farm. There are no additional wind farm developments within the Ffrwd Wyllt catchment.

10.10.2 Foel Trawsnant is a consented wind farm near the northern section of the proposed development which is within the catchment of the River Avan/Afon Afan, however there is no detail on the timings for this project and it is understood that a new application has been submitted via a Section 73 of the Town and County Planning Act to modify the turbine dimensions. The Scoping stage Fforch Dwm wind farm would be within the River Avan/Afon Afan catchment.

10.10.3 Within the wider River Avan/Afon Afan and the Llynfi River catchments there are several operational wind farms situated upstream within 10 km of the proposed development including Ffynnon Oer Wind Farm, Llynfi Afan Wind Farm, and Pen y Cymoedd Wind Farm.

10.10.4 There are also several non-wind developments within the wider River Afan/Afon and Llynfi River Catchments, comprising housing developments, an adventure holiday resort and an energy recovery facility. Eirlys solar farm, which is located immediately south from the proposed development, appears to be hydrologically separate from the proposed development, however nonetheless generally solar farm schemes do not tend to give rise to significant hydrological, geological or hydrogeological effects by their nature.

10.10.5 Off-site cumulative hydrological effects are primarily related to changes in water quality and increases in flood risk. Mitigation has been presented in Section 10.7 to adequately protect on-site hydrological receptors and therefore will be suitable to ensure the protection of those situated downstream and should not contribute to or exacerbate any effects arising from other developments, land uses or activities. With regards to flood risk specifically, the design of the drainage will mimic the existing hydrological and greenfield regime of the proposed development area, as outlined in Section 10.7.

10.10.6 It is concluded that following the successful implementation of the mitigation outlined in Section 10.7, cumulative impacts of the proposed development during construction and during operation will be negligible.

10.11 MONITORING

10.11.1 Monitoring for the proposed development will be required and will be confirmed post-consent. A breakdown of the proposed monitoring methodologies has been provided to consider sensitivities of the on-site and downstream environments.

10.11.2 The details of any required water quality monitoring should be discussed and agreed with NRW, NPTCBC and BCBC prior to commencement. The extent and the frequency of the monitoring will be proportionate to the level of activity on site during the construction, operation and decommissioning of the proposed development. Appropriate monitoring is important to:

- Provide reassurance that established in-place mitigation measures are effective and that the proposed development is not having any significant adverse effect upon the environment;
- Indicate whether further investigation is required and, where pollution is identified, the need for additional mitigation measures;
- Confirm that construction has not increased flood risk;
- Reduce or remove any impacts on the water environment (including Nant Cwmwernderi, Ffrwd Wyllt catchment including Nant Dysiog);
- Confirm that there has been no impact on PWS; and
- Understand the long-term effects of the proposed development on the natural environment.

10.11.3 A baseline surface and ground water monitoring programme will be undertaken prior to the commencement of construction works. The establishment of a baseline is very important as it provides a suite of parameters and flow rates against which to compare samples taken during the proposed development's lifetime, and with which to assess any impacts and the requirement for any appropriate remedial measures. However, due to the variance in climatic conditions, recording like for like water quality prior to and during construction is likely to be unusual. Therefore, it is also recommended that control sites, situated upstream and outside the area affected by the proposed development infrastructure are also established at the same time.

10.11.4 It is recommended that flow monitoring is undertaken during all phases of the proposed development to demonstrate that there has been no exacerbation of downstream flood risk.

10.11.5 Following further investigation of the identified private water supplies it might be that monitoring is required during construction of the proposed development.

10.11.6 The success of the NFM would be measured through dipwell monitoring to determine increase in groundwater level.

10.11.7 A suitably qualified ECoW will be employed throughout the construction of the proposed development. The appointed ECoW can provide advice to the contractors about how environmental effects can be minimised, and what methods can be employed to reduce effects on water quality, soils and associated habitats.

10.11.8 Monitoring will be undertaken throughout construction of the proposed development. The monitoring will help to identify areas where infrastructure is having a negative effect on water quality and quantity, peaty soils and utilise the appropriate methods to prevent further deterioration and/or promote further enhancement.

10.11.9 All construction management and water management techniques will be agreed prior to construction. The techniques would be agreed following consultation with, NRW, NPTCBC and BCBC. In conjunction with this, there should be a programme of visual monitoring to ensure that the designed drainage system is functioning well. In addition to this, PWS monitoring will be undertaken to ensure that supply quality and quantity is not altered as a result of the construction and operation of the proposed development.

10.12 DECOMISSIONING

10.12.1 During decommissioning of the proposed development, potential impacts on the hydrological, geological and hydrogeological environment are expected to be less than those encountered during the construction phase and therefore "not significant". No specific mitigation measures in addition to those noted for the construction phase are therefore identified.

10.12.2 The decommissioning of the proposed development would adhere to the latest legislative and guidance requirements at the time.

10.13 SUMMARY

10.13.1 An assessment has been carried out of the likely impacts of the proposed development on the hydrological, geological and hydrogeological environment. The assessment has considered site preparation, construction and operation of the proposed development.

10.13.2 The potential effects on the hydrological, geological and hydrogeological environment have considered, pollution incidents, erosion and sedimentation, changes in water quality, changes to water resources i.e., Cwmwernderi Reservoir and private water supplies, modification of surface water and groundwater flows, modification of natural drainage patterns, impediments to flow and flood risk, peat instability and compaction of soils.

10.13.3 Following the identification and assessment of the key receptors, taking into account the potential effects listed above, mitigation and good practice measures has been incorporated into the design, including buffer areas. In addition, a site-specific CEMP as well as detailed design of infrastructure and associated mitigation will be implemented to protect the groundwater and surface water resources from pollution and minimise changes to the hydrological environment.

10.13.4 Production of a CEMP is in line with the Well-being of Future Generations (Wales) Act 2015[17] goal 'a resilient Wales's for '*a nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change*'.

10.13.5 The impact assessment has taken into account the hydrological regime, highlighting that the principal effects will occur during the construction phase. Following the successful design and implementation of mitigation measures the significance of construction effects on all identified receptors are not defined as significant. The assessment of predicted operational effects has determined that the significance of effects on all receptors to be of no significance. A 50 m micrositing allowance for infrastructure, where it doesn't infringe on recognised sensitive receptors, has been applied to the assessment, and is considered in the significance of effects,

10.13.6 Good practice design and construction of the proposed development delivered through a skilled team of competent workers, with mitigation and compliance monitored in collaboration with NRW, NPT, BCBC and other engaged stakeholders, will result in a risk that is considered to be **not significant** in the professional judgment of Natural Power.

[17] Available from https://www.legislation.gov.uk/anaw/2015/2/contents/enacted [Accessed: 05/08/22]