

8. Hydrology & Hydrogeology

Introduction and Scope

- 8.1 An assessment of the impact of the Proposed Development on hydrogeology and hydrology, inclusive of the impact on the peat hydrology is provided in the following chapter. Statutory responses to the scoping document and recent Welsh Government advice on Sustainable Drainage Systems (SuDS) have been used to determine the scope of the assessment.
- 8.2 This chapter presents the findings of the assessment of the potential hydrological and hydrogeological effects of the Proposed Development. The assessment includes a review of the hydrology of water features such as springs, reservoirs, ponds, watercourses, wetlands and water supplies.
- 8.3 The assessment provides baseline information, identifies potential effects, assesses the significance of these effects (based on the magnitude of the effect and the sensitivity of the site), and discusses management and monitoring measures. It also outlines mitigation measures to manage the predicted effects of the proposals and assesses the residual impacts of any effects.
- 8.4 The majority of potential hydrological effects from the Proposed Development may arise from construction activities, and this chapter should be read alongside Chapter 3: Proposed Development. In turn, hydrological and hydrogeological effects may create secondary effects on ecology, and therefore reference should also be made to Chapter 6: Ecology and biodiversity.
- 8.5 The assessment is primarily concerned with the site and its surroundings up to 1 km from the site boundary. However, where a hydrological connection deems it necessary the study area has been extended to those water catchments considered to be potentially affected by the development. The planning application boundary is shown on Figure 1.2.
- 8.6 Effects on peat are considered in relation to hydrology.
- 8.7 The track widening works to the existing NRW Forestry track are considered to have negligible impact on hydrology and hydrogeology and therefore are not included in this assessment. Works are limited to minor widening, including a possible minor diversion, of the existing forestry track and diversions of existing drainage features, e.g. swales. No peat was encountered on the site walkover inspections.
- 8.8 This chapter is supported by the Sustainable Drainage Management Plan, included in Appendix 3.2 and Figure 8.1 included in Volume 3.

Legislation, Policy and Guidelines

Legislation and Policy

- 8.9 The Welsh Government has recently confirmed its intention to bring Schedule 3 of the Flood and Water Management Act 2010 into effect in Wales in January 2019. Statutory National Standards (SuDS Standards) on the design, construction, operation and maintenance of SuDS will be published by the Welsh Ministers.
- 8.10 A SuDS approving body (SAB) will be established in the local authority to approve SuDS for Developments of National Significance (DNS). Approval for the Development's SuDS design will be sought from the SAB prior to construction commencing.
- 8.11 Natural Resource Wales (NRW) has statutory obligations in terms of the management and control of pollution into water resources. NRW's Best Practice Guidelines will be followed in order to prevent pollution, to provide acceptable standards of work and to make any 'significant' effects unlikely.
- 8.12 There is a range of environmental legislation that any development must adhere to throughout the development life cycle. Key legislative drivers relating to the water environment which have been considered within this assessment are listed below:
- Environment (Wales) Act 2016.
 - EU Water Framework Directive 2000/60/EC.
 - Groundwater (England and Wales) Regulations 2009.
 - Water Supply (Water Quality) Regulations 2010.
 - Flood and Water Management Act 2010 (FWMA).
 - EC Fisheries Directive (78/659/EEC).
 - Water Resources Act 1991.
 - Private Water Supplies (Wales) Regulations 2010.
 - Environmental Protection Act 1990.
 - The Environment Act 1995.
 - Land Drainage Act 1991.
- 8.13 The development activities associated with the construction of the Proposed Development will need to conform to existing water legislation in Wales, and with any relevant changes regarding the abstraction of water, discharges to water and any engineering works or impoundments. These include the following requirements:
- Consent for the erection of a culvert in an ordinary watercourse or to alter any culvert in a manner that would be likely to affect the flow of an ordinary watercourse (Lead Local Flood Authority).

- Consent for the erection of any mill dam, weir or other like obstruction to the flow of an ordinary watercourse or to raise or otherwise alter such an obstruction (Lead Local Flood Authority).
- An Abstraction Licence for the abstraction of water from any inland water or underground strata (NRW).
- Assurance that riparian owners common law rights to receive water is undiminished in quantity or quality.

Guidelines

8.14 The Guidance for Pollution Prevention (GPP), published by NRW and the Construction Industry Research & Information Association (CIRIA), include the documents referred to below, which are the principal documents used for guidance on preventing contamination of surface water from construction activities. Those relevant to the Proposed Development include:

- GPP4: Treatment and disposal of wastewater where there is no connection to the public foul sewer, First Edition Oct 2017.
- GPP5: Works and maintenance in or near watercourses, Version 1.2 February 2018.
- Control of water pollution from construction sites. Guidance for consultants and contractors C532 (CIRIA 2001).
- The SuDS Manual 2015. CIRIA C753.

8.15 Other relevant guidance includes:

- Welsh Assembly Government Planning Policy Wales Technical Advice Note (TAN) 15, Development and Flood Risk.
- Assessing the impact of wind farm developments on peatlands in Wales, Countryside Council for Wales.
- Engineering in the Water Environment, Good Practice Guide, Temporary Construction Methods, First Edition, March 2009, SEPA.
- DEFRA Good Practice Guide for Handling Soils (MAFF, 2000).

Consultation

8.16 A range of consultation has been undertaken for the site. A summary of the consultee responses in relation to hydrology and hydrogeology is provided in Table 8.1.

Table 8.1 Summary of Consultation Responses

Consultee	Summary of Comments	Response/Action Taken
PINS	The effects on peat hydrology must be assessed.	Issues identified in the scoping response will be covered across

Consultee	Summary of Comments	Response/Action Taken
	<p>An assessment of the hydrological impacts resulting from the turbines, infrastructure and construction on contiguous habitats with shared or connected hydrology will need to be made.</p> <p>The ES should include details of any watercourse crossings and measures to protect riparian linked habitats.</p> <p>The biggest risk from a pollution viewpoint, occurs during construction with silt as suspended solid runoff. The developer should therefore plan the work carefully, so that contaminated water cannot run uncontrolled into any watercourse. It is recommended that a Construction Environmental Management Plan is produced.</p>	<p>this assessment and in the Sustainable Drainage Management Plan.</p>
Bridgend County Borough Council	<p>No concerns regarding flood risk.</p> <p>No major surface water assets within the site boundaries.</p> <p>Flows into the numerous small watercourses / ditches must be maintained.</p> <p>No diversions / culverting without discussion with and approval from the Flood and Coastal Management Section of Bridgend County Borough Council.</p> <p>Mitigation measures to control and manage run-off from any impermeable areas.</p> <p>The site may contain evidence of former mineral workings, including shafts and advice on known workings should be obtained from the Coal Authority.</p>	<p>Issues identified by BCBC will be covered across this assessment.</p> <p>Refer to N A Brown and RSK Site Investigation reports included in Appendix 2.1 and 2.2 for information on geology / mining.</p>
NRW	<p>A meeting was held with NRW on 13th December 2017.</p> <p>Reference provided to various pollution and hydrology guidelines on the NRW website.</p> <p>Reference provided to document Assessing the impact of wind farm developments on peatlands in Wales, Countryside Council for Wales.</p> <p>Advised to avoid deep peat and address the effects of the wind farm on peat hydrology.</p>	<p>Issues identified in the meeting will be covered across this assessment and in the Sustainable Drainage Management Plan.</p>

Other Consultation

- 8.17 Consultation was undertaken with local landowners in order to identify the location and nature of private water supplies.

Assessment Methodology

Baseline Characterisation

8.18 Baseline characterisation considers the current hydrological and hydrogeological characteristics of the site to inform the assessment of the effects of construction and operation of the Proposed Development on the existing conditions. The baseline characterisation has been developed through a combination of a desk-study of data sources and a site walkover.

Study Area

8.19 The hydrological study area encompasses catchments draining the site. The study area extends 1km from the site boundary to include areas downstream of the watercourses on site. Outwith this boundary it is considered that any impact from the Proposed Development would not be detectable due to the number of tributaries that join the assessed receptors. The extent of the hydrological study area takes a precautionary approach to ensure that all potential effects are identified.

Data Sources and Guidance

8.20 The following data sources have been consulted as part of the preparation of this assessment:

- Ordnance Survey (OS) Mapping at scales 1:10 000, 1:25,000 and 1:50 000 scale;
- British Geological Survey (BGS) Groundwater Vulnerability Map of Scotland 1995 at 1:625,000 scale;
- British Geological Survey (BGS) Hydrogeological Map of Scotland 1998 at 1:625,000 scale;
- River Basin Management Plan Western Wales River Basin District. (<https://naturalresources.wales/media/674895/ww-rbmp.pdf>);
- NRW information on known local abstractions (<https://nrwregulatory.naturalresources.wales/Permits>);
- NRW Flood mapping (<https://naturalresources.wales/evidence-and-data/maps/long-term-flood-risk/?lang=en>).

Significance Criteria

8.21 The significance of effects of the Proposed Development on existing baseline conditions are assessed using professional judgement through a combination of the magnitude of the potential effect and the sensitivity of the receptor to determine the significance of that effect.

8.22 Magnitude, sensitivity and significance criteria were developed for the conditions and environments prevailing at the site. Magnitude criteria are presented in Table 8.2.

Table 8.2: Effect Magnitude Criteria

Magnitude of Potential Effect	Definition
Major	Total loss of, or alteration to, key features of the baseline environment such that post development characteristics or quality would be fundamentally or irreversibly changed.
Moderate	Loss of, or alteration to, key features of the baseline resource such that post development characteristics or quality would be partially changed.
Minor	Small changes to the baseline resource which are detectable, but the underlying characteristics or quality of the baseline situation would be similar to pre-development conditions.
Negligible	A very slight change from the baseline conditions, which is barely distinguishable, and approximates to the 'no-change situation'.

8.23 Where appropriate, the probability, duration and proximity to proposed infrastructure of any effect will be discussed in relation to the magnitude.

8.24 Sensitivity criteria can be based on the degree of environmental response to any effect. This is frequently indicated by the classification of the receptor (e.g. a watercourse with a 'High' ecological status should be considered more sensitive to an effect than a watercourse with 'Poor' status). Only one of the definitions of a particular sensitivity classification needs to be met for a receptor to be included within that classification. The sensitivity criteria developed for this site are presented in Table 8.3.

Table 8.3: Sensitivity Criteria

Sensitivity of Environment	Definition
Not Sensitive	Environment is insensitive to impact showing no discernible change. Receptor lies outside the sphere of influence of the Proposed Development.
Low	Environment responds in a minimal way to effect, such that only minor change(s) are detectable. Water body is classified by EA / NRW as being Poor or Bad. Receptor is at low risk from flooding (less than 0.1% AEP). Receptor not used for water supplies (private or public). Soil type and associated land use not sensitive to change in hydrological regime (e.g. intensive grazing of sheep and cattle).
Moderate	Environment clearly responds to effect(s) in quantifiable and/or qualifiable manner. Water body is classified by EA / NRW as being Moderate. Receptor is at moderate risk from flooding (0.1% Annual Exceedance Probability (AEP) to 0.5% AEP) but does not act as an active floodplain or flood defence. Moderate classification of groundwater aquifer vulnerability.

Sensitivity of Environment	Definition
	Soil type and associated land use is moderately sensitive (e.g. arable, commercial forestry)
High	<p>Environment is subject to major change(s) due to effect.</p> <p>Water body is classified by EA / NRW as being High-Good status or is close to the boundary of a classification: Moderate to Good or Good to High.</p> <p>Nationally designated sites such as SSSIs, or non-designated sites meeting SSSI selection criteria, National Nature Reserves (NNRs), Marine Nature Reserves, Nature Conservation Review Grade 1 sites (Ratcliffe 1977) which may depend upon the hydrology of the site.</p> <p>Receptor is at risk from flooding above the 0.5% Annual Exceedance Probability (AEP) and/or water body acts as an active floodplain or flood defence.</p> <p>Receptor is used for public and/or private water supply (including Drinking Water Protected Areas).</p> <p>Groundwater vulnerability classified as high.</p> <p>Presence of a Groundwater Dependent Terrestrial Ecosystems (GWDTE) as defined by NRW.</p> <p>Soil type and associated land use is highly sensitive (e.g. an impermeable soil with artificial drainage present).</p>

8.25 The combination of magnitude and sensitivity combine to provide a matrix categorisation of significance. These are presented in Table 8.4. If the receptor is insensitive then there will not be a significant effect irrespective of the magnitude; therefore this level of sensitivity is excluded from Table 8.4.

Table 8.4: Effect Significance Criteria

Magnitude of Potential Effect	Sensitivity		
	High	Moderate	Low
Major	Major	Major	Moderate
Moderate	Moderate	Moderate	Minor
Minor	Moderate	Minor	Negligible
Negligible	Minor	Negligible	Negligible

8.26 Effects which are judged to be moderate or major are considered significant in relation to the EIA Regulations. Mitigation/management is proposed to reduce the level of significance to negligible or minor.

Baseline Conditions

Site Walkover and Surveys

8.27 A site walkover of the main site to assess hydrological features was undertaken on 9 June 2016 by Mark Crabtree of Renewable Energy Systems Ltd. Weather on the day of the site visit was dry.

- 8.28 A site walkover of the access track to assess hydrological features was undertaken on 22 September 2016 by Mark Crabtree of Renewable Energy Systems Ltd. Weather on the day of the site visit was dry.
- 8.29 The site walkovers confirmed that watercourses shown on the OS 1:50,000 scale mapping existed on the ground. The site visits also assessed the watercourse conditions and underfoot conditions (such as soil moisture) for the indicative access track routes and turbine locations. Photographs were taken to record proposed watercourse crossings, and to identify receptors and any other hydrological features of note.
- 8.30 Site walkover surveys and peat probing were undertaken between 21 and 22 September 2017 by Stephen Holmes and Chris Newman of Ramboll. The findings of the surveys have been used to determine the baseline peat depths within the site boundaries.
- 8.31 Following an update to the location of T3 further intrusive surveys and peat probing were undertaken between 4 and 10 June 2018 by RSK.

Land Cover and Land Use

- 8.32 Features associated with historical coal mining activities are evident on site. More information on the historic coal mining activities can be found in Chapter 2 and Appendices 2.1 and 2.2. Current land use consists of mainly mixed sheep and cattle hill farming. Ground cover consists of rough grassland. More information on vegetation types and classes can be found in Chapter 6: Ecology and Biodiversity.

Meteorological Summary

- 8.33 The site is subject to high annual average precipitation from rainfall and snowfall. The site has a mild climate, with an unevenly distributed annual rainfall and strong winds. According to the Flood Estimation Handbook, total annual average rainfall is some 2365mm over the site¹. On average, snow lies at the site between 40 and 60 days per year².

Geology

- 8.34 Drift deposits are shown to be absent from the vast majority of the site, although nominal soil cover is anticipated. Isolated patches of Glacial Till are shown to be present along the eastern site boundary, which form the feather edge of a larger

¹ Centre for Ecology and Hydrology (2009) Flood Estimation Handbook Version 3.

² <https://www.metoffice.gov.uk/public/weather/climate> (accessed August 2018)

- body of Glacial Till aligned with the Cwm Ogwr Fawr valley to the east of the site boundary.
- 8.35 Peat was found to be predominantly shallow or absent within most of the site. However, peat accumulations are present locally within the site. Refer to Figure 8.1: Peat Depth Plan
- 8.36 The peat at the site appeared severely degraded / modified by grazing and agricultural schemes. Natural erosion of the Peat gives rise to minor disruption of the ground surface.
- 8.37 The Rhondda Member is denoted to outcrop through the centre of the site along the central ridge and is described by the BGS as a green-grey, lithic arenites (“Pennant sandstones”) with thin mudstone/siltstone and seatearth interbedded with thin coals.
- 8.38 The Llynfi Member is denoted to underlie the Rhondda Member and outcrop along the flanks of the central ridge. Described by the BGS as a green-grey and blue-grey, feldspathic, micaceous lithic arenites (“Pennant sandstones”) with thin mudstone/siltstone and seatearth interbedded with thin coals.
- 8.39 Mapped coal seams (both observed and inferred) are present within all solid geology denoted to underlie the site.

Hydrogeology

- 8.40 NRW have not assigned an aquifer status to the Glacial Till and is therefore assumed to be a non-aquifer. The site is not located in a source protection zone. The risk that the development will adversely impact controlled groundwater is considered as a low sensitivity receptor.

Groundwater: Vulnerability to Pollution

- 8.41 The soil layers present within the site are characterised as being made up of mainly low risk and weakly permeable geology. This means that pollutants from point sources are highly unlikely to penetrate through to the groundwater. In terms of risk to groundwater quality, the site therefore carries a low risk of potential pollutants penetrating through to groundwater.

Private Water Supplies

- 8.42 There are no private water supplies in the vicinity of the site relying on sources originating from springs and wells, rather than surface water. The NRW Public register for Water Resources Licences provides details of applicants with abstraction licenses within Bridgend. There are no water abstractions within 5km of the site.

Hydrology

- 8.43 The rivers Ogwr Fawr and Afon Garw flow north to south through valleys located to the east and west of the site respectively. The river Afon Afan flows from east to west to the west of the site. The site contains the headwaters of a number of small watercourses which drain down towards the Afon Garw, Afon Afan and Ogwr Fawr.
- 8.44 Turbines T1 and T7 are located in the catchment of a number of unnamed tributaries that flow into the Afon Garw.
- 8.45 Turbine T2 is located in the catchment of the Nant Ty a tributary to the Afon Afan.
- 8.46 Turbine T3 is located in the catchment of Nant y Moel, a tributary to the Ogwr Fawr.
- 8.47 Turbines T4, T5, and T6 are located in the catchment of a number of unnamed tributaries that flow into the Ogwr Fawr.
- 8.48 The Afon Garw has a 'Moderate' ecological status under the NRW / EA River Basin Management Plan (RBMP) classification. The Afon Garw has a 'Moderate' Ecological Potential for a Heavily Modified Water Body (HMWB) status under NRW / EA RBMP classification. The Afon Garw can be considered a moderate sensitivity receptor.
- 8.49 The upper reaches of the Afon Afan catchment has a 'Good' status under the NRW / EA RBMP classification. Given these designations, the Afon Afan is considered a high sensitivity receptor.
- 8.50 The Ogwr Fawr has a 'Poor' ecological status under the NRW / EA RBMP classification. The Ogwr Fawr can be considered a low sensitivity receptor.
- 8.51 For the purposes of assessing the effect of the Proposed Development on surface hydrology, the Afon Garw, Afon Afan, and Ogwr Fawr watercourses are considered the principal receptors as they cover the entire site. Whilst other smaller streams are found on site, they are tributaries of the Afon Garw, Afon Afan, and Ogwr Fawr and so are implicitly considered in the assessment.

Surface Water Discharges

- 8.52 There are no consented surface water discharges within the site boundary.

Flooding

- 8.53 Bridgend County Borough Council was consulted regarding flood risk in the vicinity of the Proposed Development. The Council stated they have no concerns with regards to flood management in the area.

- 8.54 The NRW indicative flood map was also examined regarding flood risk. The flood mapping demonstrated that there is no risk of flooding within the site boundary.
- 8.55 Given the above, the site would not be categorised as sensitive to flood risk. The assessment will consider the impact of alterations to the runoff regime within the site bounds and the resultant impact on the downstream receptors.

Potential Effects

- 8.56 Possible hydrological and hydrogeological effects from the construction, operation and decommissioning of wind farms are related to:
- **Groundwater and surface water quality** - oil/fuel/chemical pollution (from for instance, accidental spillage or incorrect transport or storage during concrete preparation and refuelling procedures, or from leaching of concrete from turbine bases and installations) could affect water quality and indirectly affect ecological receptors and also human activities such as water abstracted for drinking supply.
 - **Erosion and sediment loading** - unmanaged erosion/sediment deposition and suspended solids generated from ground disturbance could be mobilised by surface run-off or cause modification to stream channel morphology, with resulting damage to habitats. Sediment could also affect water abstracted for drinking supply.
 - **Natural drainage patterns/runoff volumes and rates** - alteration of existing drainage could disturb surface and subsurface water flows to either water dependent habitats or to water supply abstraction points, unless properly managed. Tracks and other hardstanding areas could provide new pathways and affect the response of the catchment to rainfall. Inappropriate water crossings could result in blockages and flooding, with the potential to exacerbate erosion. Storage of peat in inappropriate locations, in combination with susceptible landforms and geology, could result in alteration of water flows, causing potential sedimentation in sensitive watercourses.
 - **Linkage between groundwater and surface water** - alterations in linkages and flow pathways between groundwater identified by the presence of Groundwater Dependent Terrestrial Ecosystems (GWDTE) and surface water during construction, operation and decommissioning.
- 8.57 The potential effects of wind farm developments are summarised in Table 8.5. It must be noted that the effects listed in Table 8.5 are only potential and their inclusion does not necessarily indicate that they will occur at this site.

Table 8.5 Summary of Potential Effects on Hydrology/Hydrogeology and Peatlands arising from Wind Farm Developments

Activity	Specific Element/Activity	Potential Effects	Potential Sensitive Receptors
Construction	Use of vehicles and machinery	Increase in surface run-off from soil compaction.	Surface water / peat hydrology and channel morphology
		Damage to peat including peat drainage.	Peat hydrology
		Long-term disruption of natural flow paths within the top of the peat body	Peat hydrology
	Works next to or near watercourses	Change in flow velocities	Surface water hydrology and channel morphology
		Increased erosion and subsequent changes in bed and bank stability	Surface water hydrology and channel morphology
		Increased flood risk	Surface water hydrology and channel morphology
		Entrance of sediment into watercourses via dust or suspended in runoff	Peat / surface water quality
	Earthworks and borrow pit operation	Increased sedimentation of watercourses / peat lands	Peat / surface water quality
		Pollution from suspended material	Peat / Surface water quality
		Disturbance of contaminated soil and subsequent pollution of watercourses and/or groundwater	Peat / Surface water quality Groundwater quality
	Materials management	Pollution from spills or leaks of fuel, oil and construction material	Peat / Surface water quality Groundwater quality
	Drainage, cable trenches and earthworks	Reduction in water table	Groundwater hydrology
		Changes to groundwater distribution and flow	Groundwater hydrology
		Creation of new drainage pathways as a result of wind farm infrastructure (tracks and cable trenches).	Peat hydrology

Activity	Specific Element/Activity	Potential Effects	Potential Sensitive Receptors
		Floating roads reduce hydraulic connectivity of peat beneath track.	Peat hydrology
	Concrete base installation	Changes to groundwater quality through leaching	Groundwater quality
		Increased drainage into void during construction	Peat / Surface water hydrology
Operation of wind farm and ongoing site maintenance	Use of vehicles and machinery	Increase in surface run-off from soil compaction Run-off from access roads	Surface water hydrology and channel morphology Surface water hydrology and channel morphology
	Site drainage	Rapid transfer of rainwater to watercourses via drains	Surface water hydrology and channel morphology
	Materials management	Pollution from maintenance work spills or leaks of fuel or oil	Surface water quality Groundwater quality
	Use of machinery	Sediment-loading of watercourses	Surface water quality
	Physical presence of turbine foundations	Possible minimal alteration of groundwater flow	Groundwater hydrology
Decommissioning	Use of vehicles and machinery to remove turbines and associated infrastructure	Temporary increase in surface run-off from soil compaction	Surface water hydrology and channel morphology
		Contamination from spills or leaks of fuel or oil	Surface water quality Groundwater quality
	Physical presence of former turbine foundations	Possible minimal alteration of groundwater flow	Groundwater hydrology
Flood events	Flooding within the site boundary	Damage to both the river crossing and the more general infrastructure of the track	Access infrastructure
		Injuries due to the presence of personnel in the vicinity of the river crossing during a flood event	Human health

Activity	Specific Element/Activity	Potential Effects	Potential Sensitive Receptors
		Personnel becoming trapped within the site during a flood event	Access and egress
		Consequences associated with flooding would be exacerbated downstream if culverting was improved at the site	Downstream sites

Mitigation and Management

8.58 From the assessment of potential effects, the following key issues which have demonstrated a potential effect significance of Minor/Moderate, Moderate and High will need particular attention for mitigation and management:

- The potential for sedimentation and/or pollution from construction operations in the vicinity of watercourses.
- Potential effects relating to leakage, inappropriate location and the use of diesel fuel, oils and other lubricants, and storage of cement and concrete additives that could leak or spill during transfer causing pollution to water features.
- Potential leakage of liquid concrete during mixing and transportation operations and leakage of liquid concrete during pours resulting in release of suspended solids into water features
- The potential for tracks and cable trenching to become preferential pathways altering sub-surface water flows.
- The potential to alter peat hydrology.
- The potential to increase flood risk to others.

Embedded Mitigation

8.59 There are a variety of best practices and recognised measures to mitigate and eliminate all of the aforementioned potential effects providing appropriate provisions are made in the design, construction planning and methodology. This includes minimising risks through alteration of layout, to removal or relocation of features. Those elements of the projects in which design layout was optimised to avoid hydrological/hydrogeological features are as follows:

Proposed Development Layout Considerations (Design)

Setback distances

- 8.60 A form of avoidance is location of turbines, tracks and other construction disturbance a minimum buffer distance from water features. Turbine centres are located a minimum of 50m from significant watercourses. A significant watercourse is defined as a watercourse that appears on 1:50,000 scale OS mapping.
- 8.61 A 10m buffer zone from construction activity will be employed for all significant watercourses in accordance with GPP5: Works or maintenance in or near water (2017). No dewatering or outflows will be permitted within the 10m buffer zones.

Avoidance of deep peat

- 8.62 Areas of deep peat within the site boundary have been avoided as far as practicable. There are no turbines located in the vicinity of deep peat (peat depth greater than 0.5m). The track layout has also been developed to avoid areas of deep peat, and where unavoidable, excavations will be kept to a minimum and floated track design adopted. Floated tracks will follow the principles of minimum disturbance of the vegetated layer. Stone / geotextile will be laid directly onto existing vegetation. In order to maintain the existing hydrology, flow balancing pipes, in the form of perforated pipes will be provided at existing flush locations.

Watercourse Crossings

- 8.63 During the design phase of the Proposed Development, hydrological constraints were identified and considered alongside others. The Proposed Development track layout was developed to avoid watercourse crossings. The track layout does not intercept any watercourses shown on 1:50,000 scale OS mapping.

Track and Cable Trenching Design

- 8.64 Tracks which are orientated at 90° to the slope contours may act to create rapid surface flows resulting in erosion of the tracks and provide a direct pathway for discharge to watercourses. Layout design has been cognisant of this risk and has minimised the use of tracks with this orientation. Inevitably some tracks do traverse contours at or close to 90° to the slope. These sections of track will require standard design features such as cut off drains, spoon drains or check dams to be installed such that water flow and sedimentation is minimised. Application of sediment control features as outlined above will reduce risk of sedimentation from the construction of tracks and cable trenches. Proposed mitigation measures reduce the potential magnitude of effect to Negligible.

Construction Phase Mitigation

- 8.65 Mitigation undertaken at the construction stage is fundamental to the development of the wind farm and involves both management and monitoring. These measures are considered as additional to those measures used to inform the Proposed Development layout. Mitigation measures presented in this section aim to reduce the significance of any effect on a receptor. Best practice will be followed throughout, and covers a number of aspects such as:
- the contractor tendering process;
 - site induction;
 - the development and implementation of a CDMS (see Chapter 3: Proposed Development for more detail); and
 - adherence to standard pollution prevention guidance.
- 8.66 Mitigation measures stated in the following sections are used to illustrate specific measures to minimise potential effects. However, the CDMS will be used to develop a detailed plan of when, and where, these measures will be implemented in order to gain maximum benefit from their use.
- 8.67 The use of a comprehensive Sustainable Drainage Systems (SuDS) design philosophy will mitigate against runoff, sedimentation and pollution events identified within this chapter. This philosophy will seek to ensure that all runoff is intercepted, prior to entering a natural watercourse.
- 8.68 Where specific activities have been identified as having a moderate significance (or higher), best practice in conjunction with specific mitigation measures will be required to reduce the significance to an acceptable level.

Specific Mitigation against a Pollution Event

- 8.69 Specific measures for the mitigation of a pollution event include:
- the placement of drip trays under plant/vehicles when not in use;
 - the regular inspection and maintenance of plant to prevent leakage of fuel or oil;
 - the use of interceptors to prevent oil/fuel/grit discharging into watercourses;
 - the bunding of any fuel or oil store to at least 110% of the volume of the contaminant being stored (or to contain 125% of the largest tank's capacity in the case of multiple storage tanks);
 - the siting of potentially polluting activities such as refuelling and vehicle maintenance within the identified construction compounds/parking area;
 - the use of impermeable membranes wherever there is a risk of a potentially polluting substance infiltrating the ground.

Procedures in the Case of a Pollution Event

- 8.70 A set of procedures to be adopted in the case of a pollution event occurring will be kept on site at all times. All construction staff will be made aware of these procedures and the location where they are kept.
- 8.71 The procedures will detail the location(s) of potential sources of contamination, the responsible person on site to deal with any contamination event, emergency contacts in the event of a spill and initial actions to be taken should any spill occur. Spill kits will be kept on site at all times and staff will be made aware of their location and procedures for use.

Specific Mitigation against a Sedimentation or Erosion Event

- 8.72 Additional to the embedded mitigation measures to maintain setback distances from watercourses, further mitigation against a sedimentation or erosion event will be the design and implementation of a comprehensive SuDS philosophy.
- 8.73 The Sustainable Drainage Management Plan (SDMP) included in Appendix 3.2 will be issued to the Contractor and will form part of the Contract documents. The mitigation measures identified in the SDMP will inform the final Proposed Development sustainable drainage strategy. The specific mitigation measures against sedimentation and erosion outlined in the SDMP will be implemented by the Contractor.

Specific Mitigation against a Runoff Event

8.74 The implementation of the controlling runoff measures identified in the SDMP will maintain the existing flow regime as far as practicably possible. Runoff from tracks and hardstands will be attenuated in swales and settlement ponds. Attenuated flows will be discharged over existing vegetation prior to discharging into receiving watercourses, as per the existing drainage regime for the site.

Specific Mitigation against altering Peat Hydrology

8.75 Measures to preserve site hydrology identified in the SDMP will be implemented during the construction phase. Good construction practice and methodologies will be incorporated into the CDMS and monitored during the construction phase. They will include but not be limited to the following:

- Measures to include the identification and demarcation of zones of sensitive drainage or hydrology in areas of construction;
- The minimisation of ‘undercutting’ of peat slopes, but where this is necessary, a more detailed assessment of the area of concern would be required;
- Measures to raise peat stability awareness for construction staff by incorporating the issue into the Site Induction (e.g. peat instability indicators, best practice and emergency procedures);
- Measures to ensure that accelerated degradation and erosion of exposed peat deposits does not occur as the break up of the peat top mat has significant implications for the morphology, and thus hydrology, of the peat (e.g. the minimisation of off-track plant movements within areas of peat); and
- The development of robust drainage systems that will not create areas of concentrated flow and that will require minimal maintenance.

Borrow Pit Surface Water Management

8.76 The borrow pit locations have been selected away from watercourses and beyond a 50m buffer area defined for site selection. Cut-off drainage and / or face crest bunding will divert surface flow around the operational areas and leave only incident rainfall to collect in the borrow pit.

8.77 All cut-off drains will be constructed in advance of any borrow pit operations occurring within the site. Borrow pit floor levels will slope gently down to the rear of the areas forming a natural pool to retain any surface water and enable suspended sediments to settle out. Water collected in a sump in the low point of the borrow pit will then be pumped to a settlement pond (located within the proposed borrow pit areas).

8.78 No water from excavations and dewatering activities will be allowed to enter surface waters directly. Stockpiles (of superficial deposits and aggregate) will be

located in suitable locations to ensure that there is no risk of material washing out and contaminating watercourses.

Foul Drainage Management

- 8.79 There are no public sewers in proximity to the site. Disposal of sewerage from temporary and permanent facilities on the site will be designed prior to construction commencing in accordance with the methods outlined in GPP4: Treatment and Disposal of Sewage where no Foul Sewer is available, and treatment systems will be sized in accordance with British Water Code of Practice - Flows & Loads.
- 8.80 Permanent welfare facilities will be located within the control building and substation compound, in the form of one toilet and two sinks. The substation location has been selected away from watercourses and beyond a 50m buffer area defined for site selection.
- 8.81 The preferred option for treatment is via a septic tank with effluent to discharge to a soakaway. Infiltration tests will be carried out to confirm the infiltration properties of the existing ground in the vicinity of the compound.
- 8.82 The necessary approvals will be sought prior to the installation of any sewage treatment system.

Management of Earthworks Stockpiles

- 8.83 It will be necessary for the CDMS to prescribe methods and timing involved in excavating, handling and storing topsoil and subsoil for use in reinstatement. A method statement to govern the process will be produced and will be based on the following principles:
- Careful consideration will be given to the location of topsoil and subsoil storage areas for all facilities during construction, either by siting in a flat dry area away from watercourses or by the addition of cut-off drains above the storage, which will help to maintain a buffer from streams. The areas will be regularly inspected to ensure that erosion of the material is not taking place.
 - The size and location of storage areas will be carefully assessed to prevent the risk of rainwater moving storage materials. In areas where there is a risk of high rainwater and erosion potential, cut off drains will be employed on the ground above storage areas to divert flow away.
 - Settlement lagoons and silt traps will be inspected regularly especially after a period of heavy rainfall. This inspection period will be agreed during the development of the CDMS. Maintenance will be carried out in periods of dry weather where possible.

Management of Excavated Peat

- 8.84 It will be necessary for the CDMS to prescribe methods involved in excavating, handling and storing peat for use in reinstatement. A method statement to govern the process will be produced and will be based on the following principles:
- Where present, the surface layer of peat and vegetation will be stripped separately from the subsoil. This will involve an excavation depth generally between 0.3m and 0.5m.
 - Peat will be stored temporarily, separate from the subsoil material.
 - Careful handling is essential to retain any existing structure and integrity of the excavated materials and thereby maximise the potential for excavated material to be used. To minimise handling and transportation of peat, peat will be replaced, as far as is reasonably practicable, in the location from which it was removed.
 - Temporary storage of peat will be minimised. Temporary stockpiles may be sprayed with water if necessary during particularly dry periods of weather to prevent the peat drying out.
 - Suitable temporary storage areas will be sited in areas with shallow peat depths and shallow gradient.
 - Reinstatement will, in all instances, be undertaken at the earliest opportunity to minimise storage of turves and other materials.
 - Timing the construction work as much as possible to avoid periods when peat materials are likely to be wettest.
 - Temporary storage and replacement of peat excavated from borrow pits should where possible occur adjacent to and within the source pit.

Water Quality - Oil, Fuel and Chemical Contamination

- 8.85 Fuel and oil spillages are potential sources of contaminants. Tracks and compounds where vehicles are re-fuelled or on stand-by, and areas where chemicals and fuel are stored, are potential sites of contamination. Construction Compounds are shown on Figure 3.10.
- 8.86 A location map of all potential contamination sources will be produced, and will include fuel, oil and chemical storage areas; vehicle compounds, refuelling sites, waste depots and on-site sewage systems. Mitigation is to be incorporated in accordance with NRW's GPPs. Best practice will be adopted for handling potentially polluting substances, such as fuel, oil, cement, and concrete additives, including:
- Designated facilities designed and used for storage and refuelling, away from watercourses.

- A list of emergency procedures, responsive to a risk assessment of areas of high sensitivity.
 - Site induction of all personnel on emergency spillage procedures and staff trained in emergency procedures.
 - A contact list for emergency services, the relevant environmental regulators, the local water supply and sewerage undertakers, the Health and Safety Executive and specialist clean up contractors, if required; and
 - Emergency response equipment available at appropriate locations.
- 8.87 In the unlikely event of an environmental pollution incident, there will be an emergency response procedure to address any accidental pollution incident. For example, a procedure requiring the use of spill kits to contain the material and procedures to ensure that NRW is notified on their Pollution Hotline number (0300 065300) within 30 minutes of an incident (unless unsafe to do so), will be applied.
- 8.88 The procedure will remain in place throughout the operational phase of the Proposed Development.

Cumulative Effects

- 8.89 A cumulative effect is considered to be an additional effect on hydrological resources arising from the wind farm development in combination with other proposed developments likely to affect the hydrological environment. At distances greater than 10 km it is considered that schemes are unlikely to contribute to a cumulative hydrological effect due to attenuation and dilution over distance of potentially polluting chemicals. Similarly, to affect the hydrology of a catchment would require the developments considered within the cumulative assessment to be located within the same catchment or aquifer (i.e. there requires to be some hydrological connectivity between developments) as the Proposed Development.
- 8.90 Consultation with the Local Authority and the Planning Inspectorate has confirmed there are no other wind farms or large infrastructure projects currently in planning, or expected to be submitted for planning approval within 10km of the proposed site.
- 8.91 Therefore, given the potential hydrological effects from development that are likely to arise from construction activities, it can be reasonably concluded that no cumulative effects would arise as a result of the Proposed Development as there are no other developments with the potential to affect the hydrology of the catchments associated with Upper Ogmore Wind Farm and Energy Storage Facility.

Conclusions and Residual Effects

- 8.92 The assessment identified areas of activity, particularly during construction and decommissioning operations which have the potential to affect the hydrology/hydrogeology of the site. Particular attention was paid to the risk of affecting peat and surface water hydrology, receiving watercourses and the potential flood risk.
- 8.93 The magnitude and significance of each of the aforementioned potential effects was assessed. Prior to mitigation, there was the potential for effects of Low to Moderate significance to occur in regard to both water quality and water quantity.
- 8.94 To reduce the significance of these effects, a number of mitigation and management measures are proposed.
- 8.95 With these measures in place, it is considered that the significance of the residual effect of the Proposed Development on the hydrology and hydrogeology of the site is negligible to minor. Table 8.6 outlines the significant effects and residual effects after mitigation.

Table 8.6: Summary of Potential Effects, Mitigation and Residual Effects

Potential Effect	Mitigation Proposed	Means of Implementation	Outcome/Residual Effect
Construction			
Sedimentation of surface water bodies from construction activities (Moderate)	Setback distances of wind farm infrastructure and spoil locations. Avoidance of watercourse track crossings. Use of comprehensive SuDS philosophy including: Settling of runoff from track construction; Use of sediment traps at regular intervals along drains; Use of check dams; Minimisation of exposed earth.	Through specification in the CDMS and final design. Through identification in the CDMS; Implementation of the SDMP. Through specific action by contractors, e.g. erection of fencing to define site bounds.	Minor

Potential Effect	Mitigation Proposed	Means of Implementation	Outcome/Residual Effect
Pollution of all three receptors (Afon Garw, Afon Afan and Ogwr Fawr) from fuel/oil spill (Moderate)	Setback distances of wind farm infrastructure from watercourses. Potentially polluting activities such as refuelling and vehicle maintenance to be contained within the construction compound and parking areas identified to reduce risk of runoff in these areas. Use of oil/fuel/grit interceptors and a roofed refuelling area. Use of drip trays under plant. Regular maintenance of plant.	Through general principles in the CDMS. Through training/induction of appropriate site personnel. Development of a pre-construction maintenance programme.	Minor
Runoff event on all three receptors (Afon Garw, Afon Afan and Ogwr Fawr) from partially constructed drainage systems (Moderate).	Phased construction of drainage systems to ensure risk is minimised at the end of each working day. Appropriate use of sustainable drainage features such as settlement ponds/swales/check dams. No drainage water to be directly discharged into natural watercourses. Minimisation of partially constructed drainage systems at times of high risk (i.e. wet weather).	Through specification in the CDMS and final design. Through specification in the CDMS and final design. CDMS to detail forward planning and use of weather forecasts to highlight high risk periods.	Minor
Alterations to peat hydrology - (Moderate)	Development of a layout that avoids deep peat.	Through appropriate design in the CDMS. Through implementation of stated mitigation measures by contractor.	Minor

Potential Effect	Mitigation Proposed	Means of Implementation	Outcome/Residual Effect
	Use of a comprehensive SuDS philosophy.		
Increased flood risk to others (Minor)	Appropriate use of sustainable drainage features such as settlement ponds/swales/check dams.	Through implementation of the SDMP. Through specific action by contractors.	Negligible
Operation			
Runoff event (blocked drainage features leading to localised flooding) (Minor)	Operational programme of maintenance to inspect culverts for blockages.	Through implementation of stated maintenance measures by the operator.	Minor
Sedimentation/pollution event (Minor)	None required (not possible to reduce residual effect below minor due to sensitivity of receptors).	n/a	Minor
Decommissioning			
Sedimentation of surface water bodies from construction activities (Moderate)	Use of comprehensive SuDS philosophy including: Minimisation of exposed earth. Planned staging of the works to retain SuDS during earthworks operations. Use of sediment traps at regular intervals along drains.	Implementation of the SDMP. Through specific action by contractors, e.g. provision of method statements and staging / decommissioning plan.	Minor
Pollution of all three receptors (Afon Garw, Afon Afan and Ogwr Fawr) from fuel/oil spill (Moderate)	Potentially polluting activities such as refuelling and vehicle maintenance to be contained within the construction compound and parking areas identified to reduce risk of runoff in these areas.	Through general principles in the CDMS. Through training/induction of appropriate site personnel.	Minor

Potential Effect	Mitigation Proposed	Means of Implementation	Outcome/Residual Effect
	Use of oil/fuel/grit interceptors and a roofed refuelling area. Use of drip trays under plant. Regular maintenance of plant.		