Chapter 8: Hydrology and Geology
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8. Hydrology and Geology

8.1. Assessment Methodology

8.1.1. This report assesses potential impacts during the pre-development tree clearance, construction, operation and decommissioning of the Project and outlines mitigation measures required to control the predicted impacts of the proposal. The scope of the assessment was to identify:

- Constraints on the Project’s activities due to hydrology, geology and soils;
- Potential impacts and risks associated with pre-development tree clearance, construction, operation and decommissioning activities that can be controlled through best management practices; and
- The significance of residual impacts.

8.1.2. Information provided within this Chapter is based upon ERM’s hydrology assessment and supplementary reports published as draft in 2011 with the Section 48 Notice, and has been updated by SKM Enviros following further field surveys and assessment.

8.1.3. The Chapter is primarily concerned with the Application Site and its surroundings up to 250 m from the application boundary. However, where a hydrological connection deems it necessary, the assessment has considered locations beyond this extent as described.

8.2. Policy Context and Guidance

8.2.1. In addition to the planning framework relevant to this application, this assessment has been undertaken with regard to statutory and general guidance, and a range of environmental legislation relating to the hydrological and geological environment, including the following:

**Statutory and General Guidance**

- Planning Policy Wales: Technical Advice Note 15 (TAN15)–Development and Flood Risk (Welsh Assembly Government 2004);
- EA Pollution Prevention Guidance Notes (PPG):
- CIRIA publications:
  - C532 Control of water pollution from construction sites (2001);
  - C650 Environmental good practice on site (2005);
- EA, Groundwater protection: policy and practice (GP3)(2008);
- Forest and Water. UK Forestry Standard Guidelines (Forestry Commission, 2011)
- DEFRA Good practice guide for handling soils (MAFF 2000); and
- DEFRA draft Code of Practice for the sustainable use of soils on construction sites.

**Legislation**

- Directive 2006/11/EC on pollution caused by certain dangerous substances discharge into the aquatic environment of the Community (Codified version)


The Freshwater Fish Directive (78/659/EEC) and the Surface Waters (Fishlife) (Classification) (Amendment) Regulations, 2003


The Floods Directive (2007/60EC)

The Civil Contingencies Act, 2004 and the Climate Change Act 2008


8.2.2. Further detail is provided below;

8.2.1. The Water Framework Directive, it’s Transposition into National Law and Associated Regional and Local Commitments

8.2.1.1. The Water Framework Directive (WFD, 2000/60/EC), currently being implemented in the UK, has the main objectives of protecting, enhancing and restoring Europe’s waters, with the aim of achieving ‘good’ status by 2015 (1), establishing a baseline of no deterioration, and encouraging the sustainable use of water resources and the water environment. It should be noted that ‘good’ status has not yet been defined across Europe. This introduces uncertainties at the current time with regard to the assessment of risks and the development of policies and measures aimed at progressing WFD objectives in this regard. The Water Environment (Water Framework Directive) (England and Wales) Regulations, 2003 represent the transposition of the requirements of the WFD into domestic law.

8.2.1.2. The next few years will see significant changes to the ways in which the aquatic environment is managed and the methods by which activities affecting surface water and groundwater are controlled and assessed. River Basin Districts (RBDs) are defined under the Directive, eleven of which fall within England and Wales (3 within Wales, including cross borders districts). The Development area is split between the Dee RBD and the Western Wales RBD. Draft River Basin Management Plans (RBMPs) for the Dee and Western Wales RBDs were published by the Environment Agency (EA) for consultation in December 2008, with final versions published in December 2009. The RBMPs set out key pressures on the water environment which could prevent achievement of the WFD objective of ‘good status’ of all water bodies by 2015, and outline the actions that will be taken to address these pressures. Key pressures identified within the Dee and Western Wales.

- alien species
- commercial fisheries (shellfish)
- mine waters
- diffuse pollution (from nitrates, pesticides, metals, phosphates, sediments, urban and transport pollution); and
- point source pollution (including organic pollution, pesticides, phosphorous and sediments)
8.2.1.3. The Environment Agency has also produced Catchment Abstraction Management Strategies (CAMS) for the Clwyd (March 2005) and the Dee (March 2008) catchments. The strategies introduce the principle of Water Resource Management Units (WRMUs) and Ground Water Management Units (GWMUs). The aim of the CAMS is to provide a framework for a consistent and structured approach to local water resources management, encouraging a balance to be found between the needs of abstractors and the needs of the aquatic environment.

8.2.2. Environmental Quality Standards, River Quality Objectives, Targets and the General Quality Assessment

8.2.2.1. River quality is one of the 68 indicators identified by the UK government’s sustainable development strategy: Securing the Future, launched in 2005, and is also one of the 20 indicators outlined within One Future – Different Paths: the UK’s Shared Framework for Sustainable Development, also released in 2005. The quality of watercourses in England and Wales is currently classified by the Environment Agency under the General Quality Assessment (GQA) scheme. Under this scheme, each watercourse is assessed separately upon its chemical, ecological (biological), aesthetic qualities and nutrient status. Additional details regarding these assessments are provided below.

- **Chemical Quality**: based upon dissolved oxygen, biochemical oxygen demand (BOD) and ammonia concentrations, the watercourse is assigned one of six grades: A (very good) to F (bad). These parameters are considered to be the best indicators of the extent to which waters are affected by wastewater discharge and rural land runoff.

- **Biological Quality**: based upon macro-invertebrate studies (an indicator of overall ecological health), one of the six grades A to F is assigned, as per Chemical Quality.

- **Aesthetic Quality**: gives an indication of our perception of river quality through the assessment of various factors including the presence of litter, foam, oil, fungus, odour and colour. The grading system ranges from 1 (good) to 4 (bad).

- **Nutrient Status**: based upon phosphate and nitrate concentrations, which are most likely to be influenced by human activity. A grade of 1 (very low) to 6 (phosphates: excessively high, nitrates: very high) is assigned.

In addition to the GQA, Environmental Quality Standards (EQSs) establish concentrations of specified substances and are either informal or statutory. Statutory EQSs are generally informed by the Dangerous Substances Directive and the Surface Waters (Dangerous Substances) (Classification) Regulations, 1997 and 1998 (see below for further information).

After the GQA has been conducted, and in light of EQSs, River Quality Objectives (RQOs) are generally introduced. RQOs set targets to aid in the protection and improvement of river quality, based upon the River Ecosystem (RE) Classification. The RE classification specifies the uses a particular watercourse should ideally be able to provide, in terms, for example, of being suitable for supporting fish. The classification is based upon quality parameters defined within the Freshwater Fish Directive and consists of five classes: RE1 (high quality) to RE5 (low quality) with an additional unclassified level for watercourses suffering from considerable pollution. No legal requirements are directly associated with RQOs. Both EQSs and RQOs are based primarily upon chemical quality and are applied to particular watercourse reaches.
8.2.3. Directive 2006/11/EC on pollution caused by certain dangerous substances discharge into the aquatic environment of the Community (Codified version)

8.2.3.1. The Directive and regulations detail the approach to be taken with respect to two categories of substances: List I and List II. Pollution by substances within List I must be eliminated, whilst pollution by List II substances must be reduced. Emission Limit Values (ELVs, also known as Uniform Emission Standards, or UESs) and EQSs have been established by a series of daughter Directives. EQSs for List II substances have been set by the UK by the UK Technical Advisory Group (UK TAG). The Dangerous Substances Directive will be repealed by the WFD in 2013. The transition requires a daughter Directive, named the Priority Substances Directive, which is currently in proposal by the European Commission awaiting approval by Member States and the European Parliament.


8.2.4.1. Specific emission limits for discharges are established under the Urban Waste Water Treatment Directive. This Directive and the transposed regulations require emission standards or percentage reduction targets to be met for effluents (based upon BOD and suspended solids).


8.2.5.1. Under the Environment Act 1995 it is an offence to discharge poisonous, noxious or polluting material into any ‘controlled waters’ either deliberately or accidentally. Polluting materials include silt, cement, concrete, oil, petroleum spirit, sewage or other debris and waste materials. ‘Controlled Waters’ include all watercourses and water contained in underground strata. Road drains and surface water gullies generally discharge into controlled waters and should be treated as such. The Water Resources Act 1991, together with changes under this Act by the Water Act 2003, requires consents to be obtained for any discharges to controlled waters. The Land Drainage Act 1991 states that consent (now known as Flood Defence Consent, FDC) will be required for works affecting drainage ditches along the route. Applications to the Competent Authority are required, which is generally the Environment Agency, but can, under some circumstances, be the controlling Internal Drainage Board (IDB).

8.2.6. The Freshwater Fish Directive (78/659/EEC) and the Surface Waters (Fishlife) (Classification) (Amendment) Regulations, 2003

8.2.6.1. The Directive and regulations aim to protect surface waters identified as being of suitable, or potentially suitable, quality for sustaining fish populations. Objectives and parameters for salmonid (1) and cyprinid (2) waters (and waters identified as being of potential suitability) are also set. The Surface Waters (Fishlife) (Classification) Regulations, 1997 represented the original transposition of the Directive in the UK. The 2003 amendment regulations transpose the Directive, which will be repealed in 2013 by the WFD.


8.2.7.1. Directive 2006/118/EC on the protection of groundwater against pollution and deterioration was provided for by Article 17 of the WFD. This Directive supplements the general rules for the protection of groundwater established through WFD in replacement

8.2.8. **Source Protection Zones**

8.2.8.1. The vulnerability of groundwater to pollution is dependent on the presence and nature of the overlying soils and drift deposits, the geology and the depth to the water table. This will determine the rate at which a contaminant can migrate into the water. The Environment Agency has identified Source Protection Zones (SPZs) across England and Wales to protect the quality of groundwater resources, primarily those used for public potable water supplies. Within SPZs there are inner and outer protection zones defined according to the above criteria. The Environment Agency’s approach to controlling and preventing the pollution of groundwater is set out in its Policy and Practice for the Protection of Groundwater (1998).


8.2.9.1. The Floods Directive came into force in November 2007. Member states have two years to transpose the Directive into National Law. Under the Directive, high level Flood Risk Assessments are required by the close of 2011, with flood hazard and impact maps being required by the close of 2013, and management plans by December 2015. Updates to these documents will be conducted every six years thereafter. The Floods and Water Management Bill, the transposition of the Floods Directive, is currently progressing through the House of Lords awaiting Royal Assent. Once adopted, the Act will transfer and alter a number of responsibilities with regards to the management of flood risk, including increasing the powers of the Environment Agency, transferring drainage and related flooding sources to Local Authorities, advancing controls on reservoir safety, and ending the automatic right to discharge to sewer for new development.

8.2.10. **Technical Advice Note 15 Development and Flood Risk**

8.2.10.1. In Wales, Technical Advice Notes (TANs) have been developed to supplement Planning Policy Wales (PPW) and to provide guidance on a number of key issues and sensitivities. Of relevance to this assessment is TAN 15: Development and Flood Risk, 2004 (1). The TAN introduces a precautionary framework, informed by a development advice map and associated ‘development advice zones’ (A, B and C (C1 and C2)) which may be used to trigger planning tests in relation to flood risk. In July 2004 the Welsh Assembly Government published Development Advice Maps (DAMS) to accompany the latest version of TAN 15 – Development and Flood Risk. Only the DAMS, which accompany TAN 15, should be used to identify relevant planning zones and whether a site falls within them. The 2004 DAMS have since been superseded (September 2009) and the updated versions are currently unavailable. The level of risk assigned to the site is not, however, believed to have been altered.

8.2.10.2. The maps are based on information provided by the Environment Agency and the British Geological Society. The maps contain three development advice zones which are attributed to different planning actions, see Table 8.1 below.
8.2.10.3. TAN 15 informs section 5.7 ‘Flood Risk’ of the Overarching National Planning Policy Statement for Energy (EN-1).

**Table 8.1 TAN15 Development Advice Zones**

<table>
<thead>
<tr>
<th>Description of Zone</th>
<th>Use within the precautionary framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Considered to be a little or no risk of fluvial or coastal/tidal flooding</td>
</tr>
<tr>
<td>B</td>
<td>Areas known to have been flooded in the past evidenced by sedimentary deposits</td>
</tr>
<tr>
<td>C</td>
<td>Based on Environment Agency extreme flood outline, equal to or greater than 0.1% (river, tidal or coastal)</td>
</tr>
<tr>
<td>C1</td>
<td>Areas of the floodplain which are developed and serviced by significant infrastructure, including flood defences</td>
</tr>
<tr>
<td>C2</td>
<td>Areas of the floodplain without significant flood defence infrastructure</td>
</tr>
</tbody>
</table>

8.2.11. The Civil Contingencies Act, 2004 and the Climate Change Act 2008

8.2.11.1. The Civil Contingencies Act 2004 (Contingency Planning) Regulations 2005 affords powers and responsibilities to Category 1 and 2 Responders for significant event situations, which includes flooding in addition to matters such as terrorist threat. Responders have defined responsibilities under the Act, which represent compliance requirements.

8.2.11.2. Requirements concerning adaptation to climate change, including flood risk adaptation, have also been introduced through the Climate Change Act 2008. Requirements for reporting on adaptation risks and capabilities are currently available in consultation draft for defined ‘Reporting Authority’ categories which include public and private bodies.


8.2.12.1. Development policies of relevance in terms of geology, water resources and flooding are listed below.

- **ENP 1: Pollution**
  - Control of development with respect to potential impact on the environment, including sea, surface water or groundwater.
- **ENP 3: Water Resources**
  - Need to demonstrate no increase in demand on existing water resources, unless adequate supply exists.
- **ENP 4: Foul and Surface Water Drainage**
  - Policy control over the disposal of foul sewage and surface water.
- **ENP 6: Flooding**
  - Control of development which could result in an unacceptable risk from flooding, either on-site or outside the site boundary.
- **ENP 7: Unstable Land**
  - Need to demonstrate that the development will not be at risk from ground instability and that it will not increase the risk of ground instability elsewhere.

8.2.13.1. Development policies of relevance in terms of geology, water resources and flooding are listed below.

- CONS 10: Planning permission will not be granted for development that is likely to have an adverse effect on the nature conservation or other scientific value of sites of special scientific interest.
- CONS 18: Development will be allowed in coastal areas or areas adjacent to rivers, subject to other structure plan policies, unless one of the following apply:
  - There would be an unacceptable risk to flooding.
  - There would be an unacceptable increase in the risk of flooding elsewhere.
  - The capability of the coast to form a natural sea defence would be prejudiced.
  - Additional public finance would be required for coastal or riparian defence works other than that necessary to protect existing investment.
  - The development would adversely affect existing or new flood defence operations

8.2.14. Pollution Prevention Guidelines

8.2.14.1. Pollution Prevention Guidelines (PPGs) have been jointly produced by the environmental regulatory authorities within the UK. PPGs of relevance to this project are referenced below.

- PPG01 General guide to the prevention of water pollution.
- PPG05: Works and maintenance in or near water.
- PPG06: Working at construction and demolition sites.
- PPG20: Dewatering underground ducts and chambers.
- PPG21: Pollution incident response planning

8.3. Consultation

8.3.1. A summary of scoping responses from the various statutory consultees is provided in the Consultation Report, which includes those responses relevant to, and now addressed in, this Chapter, i.e. those received from CCW, EAW, Denbighshire County Council and Conwy County Borough Council.

8.3.2. Within the final ES account has been taken of the Section 42 consultation responses received with regard to hydrology, as summarised in Table 8.2. The Section 47 consultation responses were also considered in the drafting of the current Chapter, as set out in the Consultation Report.
### Table 8.2 Summary of issues identified during S42 consultation

<table>
<thead>
<tr>
<th>Consultee</th>
<th>Issue</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment Agency Wales</td>
<td>Lack of information over mitigation proposed if there is a permanent deterioration of any PWS.</td>
<td>Assessment of PWS is detailed within Annex 8.5. Mitigation measures are detailed within the annex and summarised within Section 8.6.3.</td>
</tr>
<tr>
<td></td>
<td>An emergency plan should be prepared for use during the construction phase should a pollution incident arise.</td>
<td>Emergency planning for spills or pollution incidents will be covered within the CEMP (outline provided in Annex 3.1).</td>
</tr>
<tr>
<td></td>
<td>A detailed drainage strategy will need to be provided and approved. The future drainage strategy needs to be succinct and outcome focussed.</td>
<td>A detailed drainage strategy will be put forward at detailed design stage of the Project. A Surface Water Management Plan has been included as Annex 8.1 which provides outline details of the proposed drainage strategy.</td>
</tr>
<tr>
<td>Several local Community Councils</td>
<td>Unacceptable approach to PWS assessment methodology and lack of acceptable solutions to detrimental residual effects.</td>
<td>Annex 8.5 provides an assessment of PWS in the vicinity of the wind farm. The ES details mitigation measures with regard to PWS in Section 8.6. The assessment has concluded that the mitigation measures proposed are considered to be suitable for protecting the water quality upon and surrounding the Application Site. Proposed mitigation measures will serve to protect PWS and mean that residual risks are not significant.</td>
</tr>
<tr>
<td>Countryside Council for Wales</td>
<td>Initial concerns over extent and detail of peat survey and subsequent assessment.</td>
<td>In response to concerns raised by CCW, additional consultation has taken place through various letters, emails, telephone conversations and a site meeting (09/10/2011) to agree the scope and methodology of further peat assessment. This included discussions regarding survey methodology, peat habitat restoration proposals; probing resolution used during the surveys, peat loss calculation and validity of previous reporting. Chapters 8 and 9 of the ES (and associated Annexes) have been updated to reflect the outcomes of the discussions and the recommendations made as a result.</td>
</tr>
<tr>
<td></td>
<td>Peat loss calculations.</td>
<td>Revised calculations based on additional survey data and agreement on extent of peat impacted through drainage influence. Revised carbon balance calculations presented within Annex 2.1.</td>
</tr>
<tr>
<td></td>
<td>Concern over proximity of the proposed development to the Mynydd Hiraethog SSSI.</td>
<td>The assessment notes that the Mynydd Hiraethog SSSI is located immediately to the west of the Application Site. A small section of the Project is located within the catchment area draining towards the SSSI, however this has been minimised through the movement of turbine T9 away from the SSSI and over the watershed boundary. No deep excavations will be required within the catchment upgradient of the SSSI. All proposed development is situated over 100 m from the boundary of the SSSI.</td>
</tr>
</tbody>
</table>
Concern over the source of the River Clwyd which is situated within Clocaenog Forest. A full analysis of the impact requested on the Clwyd catchment in terms of: catchment flows and also the potential for flooding downstream due to felling and ground cover clearance.

Potential issues of impact on flow and of flood risk are addressed within this and the Flood Consequence Assessment provided as Annex 8.4. The assessments conclude that the residual risks to surface water features, including the River Clwyd, are considered to be Minor and are therefore not significant in terms of EIA regulations.

Concern expressed over assessment of PWS and potential pollution of supplies.

Annex 8.5 provides an assessment of risk to all PWS within 2km of the site. The assessment methodology has been based on available best practice guidance and professional judgement. Reference was also made to the UK Drinking Water Inspectorate (DWI) guidance on private water supplies and the Private Water Supplies website.

### 8.4. Assessment Methodology and Significance Criteria

This section outlines the methodology adopted to assess the environmental effects of the Project upon the local water environment and underlying geology. Environment Agency Wales requested that the following points be addressed with regards to assessment methodology:

- A map of water features to be included in the EIA, coupled with an assessment of groundwater in terms of quantity and quality.
- Specific details with regards to turbine location and methodology of emplacement with respect to hydrological and hydrogeological constraints.
- Provision of mitigation recommendation to ensure that surface runoff does not increase during construction or following the development.
- Consideration of waste management within the context of wind farm development.

#### 8.4.1. Assessment Methodology

8.4.1.1. The methodology is based upon the data sources outlined in Table 8.3.

##### Table 8.3 Data sources

<table>
<thead>
<tr>
<th>Topic</th>
<th>Source of data and information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topography</td>
<td>Ordnance Survey mapping</td>
</tr>
<tr>
<td>Elevation, relief</td>
<td>Landranger Series (1:50,000) Denbigh and Colwyn Bay, Sheet 116</td>
</tr>
<tr>
<td></td>
<td>Explorer Series (1:25,000) Vale of Clwyd, Sheet 264</td>
</tr>
<tr>
<td>Surface Water</td>
<td>Environment Agency Wales (EAW) – Interactive Maps</td>
</tr>
<tr>
<td>Flooding</td>
<td>Water Framework Directive</td>
</tr>
<tr>
<td>Water Quality</td>
<td>Water Quality</td>
</tr>
<tr>
<td>Recreational waters and fisheries</td>
<td>Flood Map</td>
</tr>
<tr>
<td></td>
<td>Freshwater Fisheries</td>
</tr>
</tbody>
</table>
### 8.4.2. Significance Criteria

8.4.2.1. There are no published guidelines or criteria for assessing and evaluating effects on hydrology or hydrogeology within the context of an EIA. This assessment is based on a methodology derived from the Institute of Environmental Management and Assessment (IEMA) guidance. The evaluation is also based on EA guidance within their recently revised Pollution Prevention Guidance documentation.

The methodology sets out a list of criteria for evaluating the environmental effects, as follows:

- The type of impact (i.e. whether it is positive, negative, neutral or uncertain);
- The policy importance of the resource under consideration in a geographical context (i.e. international, national, regional or local), and on a scale of sensitivity (i.e. high, medium or low) as defined within Table 8.4;
- The magnitude of the impact in relation to the resource that has been evaluated, quantified using the scale high, medium or low, defined within Table 8.5; and
- The probability of the impact occurring based on the scale of certain, likely, or unlikely.

#### Table 8.4 Definitions of Policy Importance and Sensitivity

<table>
<thead>
<tr>
<th>Importance and Sensitivity Context</th>
<th>Hydrological definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>International and/or High</td>
<td>Important on a European or global level e.g. RAMSAR Sites, Habitats Directive Sites</td>
</tr>
<tr>
<td>National and/or High</td>
<td>Important in Wales e.g. SSSIs. Public water supplies and highly productive aquifers. Local water supplies, including private water supplies where there is no alternative to private supplies.</td>
</tr>
</tbody>
</table>

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## Importance and Sensitivity Context

<table>
<thead>
<tr>
<th>Importance and Sensitivity Context</th>
<th>Hydrological definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional and/or Medium</td>
<td>Important in the context of the region; e.g. catchment scale issues. Private water supplies, located within vicinity of mains water supply. Private water supplies used only for agricultural purposes and not drinking water.</td>
</tr>
<tr>
<td>District and/or Medium</td>
<td>Important in the context of the local district e.g. Secondary A (locally important) aquifers.</td>
</tr>
<tr>
<td>Local and/or Low</td>
<td>Important within watersheds to which the site may drain; within the site and immediate vicinity e.g. Secondary B aquifer and minor watercourses.</td>
</tr>
</tbody>
</table>
### Table 8.5 Magnitude of Effect Criteria

<table>
<thead>
<tr>
<th>Magnitude of effect</th>
<th>Runoff regime</th>
<th>Surface water quality</th>
<th>Water Supply</th>
<th>Riverine flow Regime</th>
<th>Riverine Morphology</th>
<th>Groundwater Levels</th>
<th>Groundwater Quality</th>
<th>Peat Deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>Change (&gt;50 %) in proportion of site rainfall immediately running off, changing surface water flows, flood risk or erosion potential.</td>
<td>Change in water quality, changing water quality status with respect to EQS(^2) for more than one month</td>
<td>the quality of the supply with respect to DWS(^3). Change in the flow of supply leading to reduction in water pressure and loss of supply</td>
<td>Change in flows of &gt;5 % resulting in a measurable change in dilution capacity or flood risk</td>
<td>Changes in erosion and deposition, with conservation interests put at risk</td>
<td>Change in groundwater levels leading to an identifiable change in groundwater flow regime and artesian flow, affecting water supplies</td>
<td>Change in groundwater quality, changing site quality with respect to DWS for more than 1% of samples</td>
<td>Development proposed on identified bodies of peat &gt;0.35m in depth</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td>Change (10-50 %) in proportion of site rainfall immediately running off, changing flood risk or erosion potential</td>
<td>Change in water quality, changing site status with respect to EQS for less than one month</td>
<td>Measurable change in the quality of the supply for less than 1% of samples with respect to DWS; Temporary discoloration and elevated sediment content.</td>
<td>Change in flows between 2-5 % resulting in a measurable change in dilution capacity and flood risk</td>
<td>Some change in deposition and erosion regimes</td>
<td>Change in groundwater levels leading to an identifiable change in groundwater flow regime. Measurable change in flow to water supplies and base flows</td>
<td>Change in groundwater quality, changing site quality with respect to DWS for less than 1% of samples</td>
<td>Development proposed on identified bodies of peat up to 0.35m in depth</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>Change (&lt;10 %) in proportion of site rainfall immediately running off, but no change to flood risk or erosion potential</td>
<td>Measurable change in water quality but no change with respect to EQS</td>
<td>Measurable change in water quality, but no change with respect DWS. No change in pressure or flow</td>
<td>Measurable change in river flows of &lt;2 %, but no change in flood risk</td>
<td>Slight change in bed morphology and sedimentation pattern. Minor rates of erosion</td>
<td>Measurable change in groundwater levels, though no appreciable change in groundwater flow regime</td>
<td>Measurable change in groundwater quality, but not changing status with regards to DWS</td>
<td>Development is not situated on areas of peat</td>
</tr>
</tbody>
</table>

\(^2\) EQS – Environmental Quality Standard, as laid down in relevant EU Directives and national legislation  
\(^3\) DWS – Drinking Water Standards
8.4.2.2. Professional judgement is used to assess the findings in relation to each of these criteria to give an assessment of significance for each impact. Impact significance is considered to be of high, moderate, low, or no significance. As a guide, a significance table has been developed whereby the combination of sensitivity and magnitude give the significance of the impact (Table 8.6).

- **Table 8.6 Evaluation of Impact Significance**

<table>
<thead>
<tr>
<th>Sensitivity of Receptor</th>
<th>Magnitude of Potential Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>International/ High</td>
<td>Moderate</td>
</tr>
<tr>
<td>National/ High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Regional/ Medium</td>
<td>Minor</td>
</tr>
<tr>
<td>District/ Medium</td>
<td>Not Significant</td>
</tr>
<tr>
<td>Local/ Low</td>
<td>Not Significant</td>
</tr>
</tbody>
</table>

The impacts recorded in highlighted cells are ‘significant’ in terms of the EIA Regulations.

8.4.2.3. To classify the probability of occurrence for a potential effect it is necessary to understand how regularly a given event or outcome will come to pass. This can be assessed in a number of ways including assessments based on historical data, quantitative analysis, or experience from other similar sites. The likelihood of occurrence of potential effect is then ranked as shown below in Table 8.7.

- **Table 8.7 Classification of Likelihood of Occurrence**

<table>
<thead>
<tr>
<th>Likelihood of Occurrence</th>
<th>Potential effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Any consequence would appear likely in the medium term and inevitable in the long term (Life time of the development).</td>
</tr>
<tr>
<td>Medium</td>
<td>Circumstances are such that an event is possible in the medium term and likely over the long term, although not necessarily inevitable.</td>
</tr>
<tr>
<td>Low</td>
<td>It is unlikely that any consequence would arise within the lifetime of the development.</td>
</tr>
<tr>
<td>Very Low</td>
<td>It is unlikely that any consequence will ever arise.</td>
</tr>
</tbody>
</table>

8.4.2.4. Once the impact significance and likelihood of occurrence have been assessed these are then combined using a risk-based effects matrix (Table 8.8) to assess the likelihood of each potential effect occurring.
Table 8.8 Risk Matrix

<table>
<thead>
<tr>
<th>Impact Significance</th>
<th>Likelihood of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Low</td>
</tr>
<tr>
<td>High</td>
<td>Minor</td>
</tr>
<tr>
<td>Moderate</td>
<td>Minor</td>
</tr>
<tr>
<td>Minor</td>
<td>Not Significant</td>
</tr>
<tr>
<td>Not Significant</td>
<td>Not Significant</td>
</tr>
</tbody>
</table>

8.4.2.5. As highlighted above for the outcomes shown in Table 8.8, effects assessed as minor or less are considered not significant in terms of the EIA regulations. If the assessment results in moderate or major effect, they are considered to be significant.

8.5. Site Description and Baseline Conditions

8.5.1. This section describes the existing hydrological, hydrogeological and geological baseline conditions within the Application Site, and where necessary up to 250 m radius.

8.5.1. Overview

8.5.1.1. The Application Site is located in Clocaenog Forest, approximately 13 km south of Denbigh in North Wales. The site covers an area of 1,584.5 ha, ranging in height from 502 m AOD on Craig Bron-banog to approximately 319 m AOD in the north of the site by Bryn Ocyn. Land use across the site is upland rotational forestry managed by FCW. A full description of the Application Site and its surroundings is provided in Chapter 3 (Project Description) and its location is shown in Figure 1.1a and 1.1b.

8.5.2. Site Visit

8.5.2.1. A detailed site visit was undertaken by SKM on the 6th January 2012 with subsequent visits through February, March and April 2012 in order to re-assess the survey work completed by ERM and to further assess the potential effects of the proposed wind farm. ERM undertook detailed site visits during 2007 – 2010. Key issues/features were identified including surface water features, dominant soil types, geology and other land use characteristics likely to influence hydrological processes.

8.5.2.2. The weather during the January 2012 site visit was clear and dry with temperature below zero degrees centigrade. The March and April site visits were predominantly dry, with average levels of rainfall over preceding days.

8.5.3. Climate and Topography

8.5.3.1. The EAW operate a rain gauge at Ruthin on the Afon Clwyd (NGR SJ 12200 59200), approximately 10 km east of the Application Site. Rainfall data collected at this site indicates an average annual rainfall of 953 mm. A second rain gauge is operated at Druid on the Afon Alwen (NGR SJ 04200 43600), approximately 8 km south of the
Application Site. The average annual rainfall recorded at this site is 1,271 mm\(^4\), which can be considered to be low to medium in terms of average annual rainfall statistics for Wales, which generally range from around 1,000 mm in coastal locations to 3,000 mm per year in more mountainous areas\(^5\).

8.5.4. Surface Water

Overview

8.5.4.1. The Application Site is split between two River Basin Districts (RBDs), namely the Dee RBD and the Western Wales RBD\(^6\). The Dee RBD covers an area of 2,251 km\(^2\) of northeast Wales, Cheshire, Shropshire and the Wirral. The Western Wales RBD covers an area of 16,653 km\(^2\), including the whole western half of Wales from the Vale of Glamorgan in the south to Denbighshire in the north. Agriculture and forestry are the main land uses in the upper part of both RBDs, and significant water management issues identified within both areas include alien species, commercial fisheries (shellfish), minewater, diffuse pollution (from nitrates, pesticides, metals, phosphates, sediments, urban and transport pollution) and point source pollution (including organic pollution, pesticides, phosphorus and sediments). The River Basin Management Plans (RBMP) for the Dee \(^7\) and Western Wales \(^8\) show that acidification and sediment pollution (both of which can occur as a result of forestry land use) are not considered to be risks for the catchment areas draining from the Application Site.

8.5.4.2. The Application Site drains into two main surface water catchment areas, namely the Afon Clwyd catchment to the north and east and the Afon Alwen catchment to the south and west. A description of the main features of these catchments is provided below. The approximate catchment boundaries and identified surface water features are shown in Figure 8.1.

Afon Clwyd Catchment

8.5.4.3. The majority of the Application Site is located within the Clwyd catchment, which drains an area of approximately 827 km\(^2\) prior to discharging into the Irish Sea on the North Wales coast. For the purposes of this assessment the catchment has been split into two sub-catchments draining the Application Site: Afon Clywd in the south; and Afon Clywedog in the north.

8.5.4.4. The main river channel of the Afon Clwyd rises in the southeast of Clocaenog Forest by Waen Uchaf, flowing southwards from the Application Site and then eastwards from Melin-y-Wig towards Ruthin. A small tributary of the Clwyd, Nant y Fridd, also rises close to the Application Site by Cefnbannog. Components of the Project located within the Afon Clwyd sub-catchment include Turbine 27(T27) and its crane hardstanding area, approximately 1.4 km of existing access tracks to be upgraded, 1.3 km of public road which may require upgrading, 0.5 km of new access tracks, 0.8 km of secondary access

\(^6\)The Environment Agency Wales is required to identify River Basin Districts under the WFD. Draft River Basin Management Plans for each RBD were published in December 2008 and the final versions were approved in December 2009.  
tracks, part of borrow pit C, the south construction compound and the southerly substation (if this substation location is chosen).

8.5.4.5. The Afon Clywedog, a major tributary of the Clwyd, rises in the north of the Application Site. The main channel rises to the north of Foel Goch and flows eastwards across the Application Site. Three tributaries of the Clywedog, namely Afon Concwest, Oernant and Nant Llyfarddu, also rise in Clocaenog Forest before flowing eastwards to join Afon Clywedog. Oernant and Nant Llyfarddu combine to form Afon Corris upstream of the confluence with Afon Clywedog. The majority of the Project is located in the Clywedog sub-catchment, including T1 to T20, T22, T23 and T27, approximately 12.0 km of existing access tracks to be upgraded, 2.7 km of public road which may require upgrading, 4.4 km of new access tracks, 4.9 km of secondary access tracks, borrow pits A and B, the north construction compound and the northerly substation.

8.5.4.6. Surface watercourses within the Clwyd catchment were visually inspected at each watercourse crossing point within the Application Site, all of which are already crossed by existing forestry access tracks or public roads. Table 8.9 presents details of each crossing point, including a description of the river channel characteristics and the condition and nature of existing crossings under forestry access tracks. Crossing locations are shown on Figure 8.1.

Table 8.9 Watercourse Crossings within the Clwyd Catchment Area

<table>
<thead>
<tr>
<th>Crossing Ref</th>
<th>Grid Reference</th>
<th>Surface Watercourse Characteristics</th>
<th>Characteristics of Crossing</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>SJ 00783 57767</td>
<td>Nant Selatar (tributary of Afon Concwest) – channel &lt; 0.5 m wide. No buffer between channel and forestry.</td>
<td>Existing culvert crossing beneath public road appears to be in good condition.</td>
</tr>
<tr>
<td>B</td>
<td>SJ 00550 57230</td>
<td>Nant Llech-waered (tributary of Afon Clywedog) – channel 0.5 to 1 m wide. 15 m buffer between channel and forestry.</td>
<td>Existing culvert under public road appears to be in good condition based upon visual inspection.</td>
</tr>
<tr>
<td>C</td>
<td>SJ 00277 56887</td>
<td>Nant Llech-waered (tributary of Afon Clywedog) – channel &lt;0.5m wide, in open clear felled area.</td>
<td>Existing culvert in reasonable condition.</td>
</tr>
<tr>
<td>D</td>
<td>SJ 00956 56361</td>
<td>Aber Terlyn (tributary of Afon Clywedog) – channel approx 0.5 m wide, gravel substrate. High suspended sediment concentration in water was observed at the time of site visit, possibly due to forestry operations upstream. No buffer between forestry and channel upstream, 20m buffer downstream of crossing.</td>
<td>Existing steel culvert, overgrown with vegetation. Ponding at upper end of culvert suggesting culvert not levelled correctly.</td>
</tr>
<tr>
<td>E</td>
<td>SJ 01274 56208</td>
<td>Unnamed tributary of Afon Corris – channel &lt;0.5 m wide, rocky bed,</td>
<td>Iron culvert approx 450 mm in diameter, in poor condition.</td>
</tr>
</tbody>
</table>

As observed during site visit in October 2008 (ERM).
8.5.4.7. In addition to the surface watercourses identified, the Clwyd catchment also contains one surface waterbody, Clywedog Reservoir (SJ 01045 57460) in the upper reaches of Afon Clywedog. Clywedog Reservoir is a man-made waterbody dammed at its downstream end, and was recently restored and upgraded for the purposes of fly fishing by Denbigh and Clwyd Angling Club. The reservoir is not used for drinking water supply. The dam acts as a barrier to fish migration as no fish pass is installed, therefore the watercourses further upstream, in the vicinity of T4, T5 and T7, will be free from migratory fish. The reservoir is stocked regularly with rainbow trout.

Afon Alwen Catchment

8.5.4.8. The west of the Application Site is located within the Alwen catchment, which drains a total area of approximately 185 km² prior to discharging into the River Dee near Corwen. Five tributaries of the Alwen are sourced within the Application Site within four sub-catchments, including the following.

- Aber Llech-Daniel in the north east of the Application Site, which drains west towards Llyn Brenig Reservoir (labelled Afon Alwen 1 on Figure 8.1), which discharges to Afon Brenig upstream of a confluence with Afon Alwen. Approximately 0.1 km of existing access tracks to be upgraded, 0.1 km of new access tracks and the northerly permanent met mast are located in this catchment area. Turbine T9 is also situated close to the watershed at the head of the catchment.
An unnamed tributary which rises near Hafotty Newydd at SJ 00300 54800 (labelled Afon Alwen 2 on Figure 8.1). Approximately 2.2 km of existing access tracks to be upgraded and 72 m of new track are located within this catchment area.

An unnamed tributary which rises northeast of Tal y Cefn Isaf at SJ 01100 52800 (labelled Afon Alwen 3 on Figure 8.11). T21, T24, T25, T26 and T28, 4.2 km of existing access tracks to be upgraded, 0.9 km of new access tracks, 0.4 km of secondary access tracks and the southerly permanent met mast are located in this catchment area.

Nant y Derwydd which rises in the south of the site and drains south towards the Afon Alwen (labelled Afon Alwen 4 on Figure 8.1). T29 to T31, 0.4 km of existing access tracks to be upgraded, 1.2 km of new access tracks, 2.0 km of secondary access tracks and borrow pits C and D are located in this catchment area.

Nant y Wrach which also rises in the south of the site and drains south towards the Afon Alwen (labelled Afon Alwen 5 on Figure 8.1). T32, 0.3 km of existing access tracks to be upgraded, 0.2 km of new access tracks and 0.4 km of secondary access tracks are located in this catchment area.

8.5.4.9. There are no watercourse crossings within the Alwen catchment.

8.5.4.10. Llyn Brenig Reservoir is located within the Alwen catchment to the west of the Application Site. The reservoir is located downstream from the Afon Alwen 1 sub-catchment and upstream from the remaining sub-catchments. No fish pass is installed therefore migratory fish will not be able to access the upstream catchments (see Section 8.5.6 for further details on fisheries). Llyn Brenig reservoir was constructed in 1976 for the purposes of river regulation. It augments the summer flow of the River Dee further downstream to maintain a reliable year round supply for a number of major public water supply abstractions, and also provides a direct public water supply.

8.5.4.11. Further details of licensed water abstractions within 5 km of the Application Site are provided below in Section 8.5.12. Dam raising at Llyn Brenig, with a transfer aqueduct to the Alwen Reservoir, has been considered by Welsh Water (referred to as DCWW) as a potential option to increase water resources in the Alwen-Dee area. This, however, is not one of the preferred options outlined in DCWW's draft Water Resource Management Plan (WRMP) and has been assessed in the Strategic Environmental Assessment (SEA) of the WRMP to have potential significant environmental impacts. The SEA concludes that the option is not considered to be appropriate as impacts are unlikely to be able to be mitigated. The potential for dam raising at Llyn Brenig is therefore not considered further in this ES as it is unlikely to be progressed.

Water Quality

8.5.4.12. EAW carries out regular monitoring on watercourses throughout Wales, and their river quality classification project is based on chemical and biological parameters. The EAW classification range extends from A (very good) to F (bad) for chemical and biological parameters. Nutrients are analysed for nitrate and orthophosphate and graded from 1 (very low presence of nutrients) to 6 (very high presence of nutrients).
8.5.4.13. There are three EAW water quality monitoring points located downstream from the Application Site, within the catchments of the rivers Alwen, Clywedog and Clwyd. The Afon Brenig, to the southwest of the Application Site, is monitored along a 6 km stretch between its confluence with the Afon Alwen (SH 97400 52800) and the inlet of the Llyn Brenig reservoir (SH 98000 58000). The Afon Clwyd, to the southeast of the Application Site, is monitored along a 16.5 km stretch between its confluence with Nant y Ffridd at Pont Petryal (SJ 03800 51400) and its confluence with Afon Hesbin (SJ 12700 55200). The Afon Clywedog, to the northeast of the Application Site, is also monitored between its confluence with Afon Concwest (SJ 04400 58200) and its confluence with Melindwr at Bontuchel (SJ 08500 57800). The most recent water quality monitoring results for these sites are presented in Table 8.10.

Table 8.10 Water Quality Monitoring Results (River Basin Management Plan 2009/2010)

<table>
<thead>
<tr>
<th>Water Quality Parameter</th>
<th>Afon Brenig SH 97400 52700 (5 km downstream from Application Site)</th>
<th>Afon Clwyd SJ 12700 55200 (17 km downstream from Application Site)</th>
<th>Afon Clywedog SJ 085 578 (7.5 km downstream from Application Site)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Biology</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Nitrates</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Phosphates</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

8.5.4.14. The WFD classification scheme for water quality includes five status classes: high, good, moderate, poor and bad.

8.5.4.15. ‘High status’ is defined as the biological, chemical and morphological conditions associated with no or very low human pressure. This is also called the ‘reference condition’ as it is the best status achievable - the benchmark. These reference conditions are type-specific, so they are different for different types of rivers, lakes or coastal waters so as to take into account the broad diversity of ecological regions in Europe.

8.5.4.16. Assessment of quality is based on the extent of deviation from these reference conditions, following the definitions in the Directive. ‘Good status’ means ‘slight’ deviation, ‘moderate status’ means ‘moderate’ deviation, and so on. The definition of ecological status takes into account specific aspects of the biological quality elements, for example “composition and abundance of aquatic flora” or “composition, abundance and age structure of fish fauna” (see WFD Annex V Section 1.1 for the complete list). These definitions are expanded in Annex V to the WFD.

8.5.4.17. The water quality of all three rivers is good or very good in terms of chemical and biological parameters. Phosphate levels are also very low in all three river stretches, while nitrate levels are moderately low in the Afon Clwyd and Afon Clywedog. The Application Site is not located within a Nitrate Vulnerable Zone (NVZ).\(^\text{12}\)

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\(^\text{12}\) Welsh Assembly Government Nitrate Vulnerable Zones Map 2008
http://wales.gov.uk/docs/desh/policy/091009/waternvzindexen.doc
8.5.4.18. As part of the Water Framework Directive (WFD), surface watercourses throughout England and Wales are also currently being assessed under a EAW rated Project to determine their ecological and chemical status, and to determine which watercourses are ‘at risk’ of failing to meet good status by 2015; a key aim of the Directive.

8.5.4.19. Under the WFD Afon Clwyd is currently classified as being of ‘moderate’ ecological status and is ‘probably at risk’ of not achieving good status by 2015. The chemical status of Afon Clwyd is ‘high’ (not requiring assessment)

8.5.4.20. Afon Clywedog is currently classified as being of ‘moderate’ ecological status, due to its lack of sustainable fish populations, and is of ‘high’ chemical status. The watercourse is ‘probably at risk’ of not achieving good overall status by 2015.

8.5.4.21. Afon Brenig is currently classified as being of ‘moderate’ ecological status, and is of ‘high’ chemical status (not requiring assessment). The watercourse is ‘at risk’ of not achieving good overall status by 2015.

8.5.4.22. The surface watercourses are of good quality and have valued ecological significance as such the sensitivity of both surface water catchments is classified as Regional/Medium.

8.5.5. Water Dependant Statutory Designated Sites

8.5.5.1. River Dee and Bala Lake Special Area of Conservation (SAC) is located approximately 10 km downstream from the Application Site via the Afon Alwen. This site is designated for its populations of Atlantic salmon (Salmo salar) and Floating water plantain (Luronium natans). Other qualifying features of the site include sea lamprey (Petromyzon marinus), brook lamprey (Lampetra planeri) and river lamprey (Lampetra fluviatilis), bullhead (Cottus gobio) and otter (Lutra lutra).

8.5.5.2. Mynydd Hiraethog Site of Special Scientific Interest (SSSI) is located immediately to the west of the Application Site, surrounding the north of Llyn Brenig Reservoir. This SSSI is designated for habitats including acid blanket bog, soligenous mires and oligotrophic lakes, all of which are dependent on the quantity and quality of surface water runoff which drains to the area. A small section of the Project (including 125 m of existing access track to be upgraded, 105 m of new access track and the northerly permanent met mast) is located within the catchment area draining towards the SSSI (Afon Alwen 1), upstream and close to the catchment watershed of Afon Llech Daniel. The location of Turbine T9 has been micro-sited, since an earlier layout, to remove the turbine excavations out of this catchment. All proposed development is situated over 100 m from the boundary of the SSSI.

8.5.5.3. Cefn Rofft SSSI lies approximately 620 m to the south of the Application Site. The SSSI is approximately 4 ha in size and is designated for its unimproved neutral grassland which occurs in association with small areas of wet acidic grassland, woodland, scrub and bracken. The SSSI is not in hydrological connectivity with the Project and is therefore not considered further within this Chapter.

8.5.5.4. The environmental designations of the land surrounding Llyn Brenig Reservoir is considered significant and has been assessed as National / High sensitivity.

Chapter 8: Hydrology and Geology

8.5.6. Flood Risk

8.5.6.1. The EA flood map for the area indicates that, although the rivers Alwen and Clwyd have a 1% probability (1 in 100 chance) of flooding from fluvial sources each year, this risk is limited to their lower reaches, several kilometres downstream from the Application Site. There are no areas or properties at risk of fluvial flooding within the Application Site.

8.5.6.2. The Application Site lies within areas classified as being within Zone A of TAN 15: Development and Flood Risk i.e. at little or no risk of fluvial or tidal/coastal flooding. There is, therefore, no need to consider fluvial or tidal flood risk further insofar as risks to the proposed Project from fluvial and tidal sources. However, there is still a requirement to demonstrate that the Project will not increase the risk of flooding downstream from the Application Site, and that other sources of flooding (such as groundwater, surface water runoff and artificial drainage sources) do not introduce risk to this Project. Additional detail with regard to sources and pathways of flooding, together with drainage design arrangements for the Project have been progressed in the form of a high level Flood Consequences Assessment (FCA) (see Annex 8.4), the scope of which has been agreed with EAW.

Fluvial Flood Risk

8.5.6.3. The Application Site is located on elevated ground, with the only connection between the Project and watercourses being at existing small culverted crossings. All turbines and infrastructure are planned for sites above the level at which flooding would occur. Fluvial flood risk within the Application Site is therefore considered to be limited to watercourse crossing points. Under the existing situation, it is considered to be likely that minor surface water flooding may occur at existing forest road crossing points, when storm flows exceed culvert capacities or if culverts become blocked.

Tidal Flood Risk

8.5.6.4. The Application Site is over 300 m above sea level at its lowest point, therefore this risk does not apply.

Groundwater Flood Risk

8.5.6.5. Groundwater flooding is not considered to be a risk, due to the relatively steep terrain, shallow soils and impermeable nature of the underlying bedrock encountered across the Application Site.

8.5.6.6. Groundwater flows are discussed further in section 8.5.9.

Surface Water

8.5.6.7. The moderate permeability of some of the soils (Section 8.5.7) in the Application Site gives rise to the possibility of surface runoff in the event of extreme rainfall and/or saturated ground conditions from preceding rainfall events. Surface runoff will also be generated from the existing semi-permeable access tracks within the Application Site.

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Deforested areas will lead to increased surface runoff in the short term (e.g. due to reduced interception of precipitation by the forest canopy, and increased soil compaction caused by heavy machinery during pre-development tree clearance operations). A full review of the impacts of deforestation on flooding is provided in Annex 8.4 and discussed further in Section 8.6.2 and Chapter 7 (Land Use and Forestry).

Artificial Drainage Systems

8.5.6.8. There are no artificial drainage systems which could present a risk of flooding to the Application Site, therefore this risk is not considered further.

8.5.6.9. Fluvial flood risk to the development is assessed as low, however, there is potential for increased risk of surface water flooding to land immediately downstream of the development. Therefore the flood risk sensitivity of the site is currently assessed as Local / Low.

8.5.7. Soil

8.5.7.1. According to the NSRI Soil Report the Application Site is covered by three soil associations. Hafren and Wilcocks 2 associations cover the majority of the Application Site, with areas of Brickfield 1 association in the south\(^1\)\(^5\)\(^1\)\(^6\). Table 8.11 describes the key characteristics of each soil association, including the comprising soil series characteristics. The full NSRI Site Soil Report can be viewed in Annex 8.3.

### Table 8.11 Soil Association Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Hafren</th>
<th>Wilcocks 2</th>
<th>Brickfield 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Loamy permeable upland soils over rock, with a wet peaty surface horizon and bleached subsurface horizon, often with thin ironpan. Some peat on higher ground. Rock and scree locally.</td>
<td>Slowly permeable, seasonally waterlogged loamy upland soils with a peaty surface horizon. Some very acid peat soils.</td>
<td>Slowly permeable seasonally waterlogged fine loamy and fine silty soils, some with wet peaty surface horizons.</td>
</tr>
<tr>
<td><strong>Composition</strong></td>
<td>Hafren (45 %) – loamy material of lithoskeletal mudstone and sandstone or slate. Hiraethog (20 %) – loamy material over lithoskeletal mudstone and sandstone or slate. Wilcocks (10 %) – loamy drift with siliceous stones. Other (25 %) – other minor</td>
<td>Wilcocks (50 %) – loamy drift with siliceous stones. Crowdy (15 %) – humified peat, up to 1m in thickness. Winter Hill (15 %) – mixed eriophorum and sphagnum peat, up to 1.2 m in thickness. Hafren (10 %) – loamy material of lithoskeletal mudstone and sandstone or siliceous stones.</td>
<td>Brickfield (30 %) – medium loamy drift with siliceous stones. Wilcocks (25 %) – loamy drift with siliceous stones. Greyland (10 %) – medium loamy over clayey drift with siliceous stones. Cegin (10 %) – medium silty drift with siliceous stones.</td>
</tr>
</tbody>
</table>

\(^1\) National Soil Resources Institute (2009). Full Soils Site Report for location 301000E 356500N, 5km x 5km, National Soil Resources Institute, Cranfield University. Accessed via https://www.landis.org.uk/sitereporter/.

### 8.5.7.2. The soil series comprising the Hafren and Brickfield 1 soil associations are characterised by shallow (10 cm to 20 cm) surface peaty horizons, beneath which are layers of clay or sandy silt loam. Two of the Wilcocks 2 comprising soil series (Wilcocks and Hafren) are also characterised by shallow (10 cm to 20 cm) surface peaty horizons, again with clay loam or sandy clay loam horizons beneath. The Crowdy and Winter Hill horizons, however, are characterised by deep peat horizons, 100 cm to 120 cm thick. The Crowdy soil series comprises dark brown or black stoneless, humified peat with a massive structure. The Winter Hill soil series comprises dark reddish brown or dark reddish grey semi-fibrous, Eriophorum-Sphagnum peat, with a moderate to weak coarse platy structure in the top 70 cm and a massive structure in the lower horizon. The Wilcocks 2 soil association includes soil series with an important peat element (i.e. the Crowdy and Winter Hill soil series). Cross reference of the NSRI soil distributions with BGS map data shows good correlation of BGS peat deposits within the Wilcocks 2 soil association, with almost all BGS peat deposits located within the Wilcocks 2 soil association.

### 8.5.7.3. Two soil infiltration tests were undertaken as part of the Flood Consequences Assessment (FCA) (Annex 8.4) in order to gain independent evidence of the rate of infiltration on site and the permeability of underlying soils. Tests were undertaken at two sites with contrasting infiltration characteristics: one in the Hafren soil type; and one in the Wilcocks 2 soil type.

### 8.5.7.4. Hafren soil type – test undertaken at grid reference SJ 01466 54664. The test result was 60 mm/hr, which is a relatively high infiltration rate and is compatible with the soil description in Table 8.11.

### 8.5.7.5. Wilcocks 2 soil type – test undertaken at grid reference SJ 00290 57470. This soil would be expected to have a lower infiltration rate than the Hafren soil type, due to its HOST classification as a permanently wet soil, over slowly permeable substrates with negligible storage capacity. The area selected for testing was extensively covered by coniferous plantation forestry, as is characteristic across the majority of the site. The test demonstrated very high rates of infiltration, sufficiently high that it was impossible to supply water quickly enough to establish a steady rate of infiltration. This was thought to be at least partly as a result of the density of tree roots in the soil, providing enhanced infiltration capacity, and may also have reflected an inability to fully drive the cylinders into the soil, again due to the root density. Although the results may not entirely reflect
conditions in the lower levels of the soil, the result provides an unverified suggestion that the underlying soil characteristics have been modified by the overlying coniferous forestry plantation, which may have increased the permeability and water-holding capacity of the soil.

8.5.7.6. The sensitivity of soils across the site is dominated by sensitive peat environments which are assessed as **Regional / Medium** sensitivity as detailed below in Section 8.5.8.

8.5.8. **Peat**

8.5.8.1. A full review of peat depth across the site is contained within Annex 8.2: Peat Depth Survey Report. The methodology for the study was based on CCW Peat Guidance, published in 2010 and extensive consultation with both CCW and FCW. Full details of consultation can be found within Section 2.6 of Annex 8.2. The study was undertaken to determine the extent of peat deposits in the development area, both to inform amendments to the Application Site layout during the design stage, and to identify areas where mitigation measures are required to minimise effects on peatland habitats during pre-development tree clearance activities and the construction and operational phases of the wind farm. The study also identified key areas of the development area with the greatest potential for peatland restoration and discussed the potential for peat instability, concluding that the risk is low and no further works in respect of peat slide risk assessment is considered necessary.

8.5.8.2. The FCW soil map was compared to the BGS and NSRI soil data to make an initial assessment of peat cover across the site this informed the desk based assessment of peat cover. The FCW soil data showed good correlation with the BGS and NSRI soil data, with all datasets indicating that the areas of deepest peat are limited to the poorly drained valley bottom areas. It is considered that the FCW soil data is the most accurate and reliable desk-based source of information, as it was produced at the largest scale (1:10,560).

8.5.8.3. Peat depth probing was then undertaken within the Application Site to identify the location, extent and condition of any unknown localised peat deposits in proximity to the Project, which are not shown on BGS map data. Probing was undertaken at all accessible turbine locations and along existing and proposed new access tracks located within the Wilcocks 2 soil association. The methodology and detailed results of the peat depth survey can be viewed in Annex 8.2 along with a comparison of these results against the FCW soils map.

8.5.8.4. Field surveys were undertaken at all turbine locations to confirm the findings of the Peat desk study (Annex 8.2) and to identify any additional peat deposits. In general the results of the desk study displayed close agreement with the findings of the intrusive peat survey. The majority of turbine and infrastructure locations across the site did not encounter significant peat deposits. Where peat deposits were encountered they were generally where predicted by the desk study.

8.5.8.5. Out of the 32 turbines surveyed, peat was only found in close proximity to four turbines (T2, T4, T11, and T29). Two other turbine locations indicated average peat depths in excess of 0.35 m, namely T10 and T13 which displayed average peat thicknesses of 0.4 and 0.39 m respectively. Peat probing undertaken at these locations indicated adequate areas of peat <0.35m to facilitate micro-siting. Turbine T10 was subsequently micro-sited to shallower peat within a 50 m radius, however T13 remains at its original location due to
proximity of the unclassified public road to the north which precludes micro-siting to where the peat is shallower.

8.5.8.6. Two additional localised area of peat deposits were identified through the field survey to the south of turbine T2, and to the north of turbine T29. The results also showed generally good correlation with BGS superficial geology data and NSRI soil distributions (discussed further within Annex 8.2) with one additional localised peat deposit identified through the field survey at T2. Two other turbine locations indicated average peat depths in excess of 0.35m, namely T10 and T13 which displayed average peat thicknesses of 0.4 and 0.39m respectively. However, many peat probes undertaken at these locations also indicated areas of peat <0.35m where the turbines could be micro-sited to within a 50m radius. Full details of micro-siting are contained within Annex 8.2 and summarised within Table 3.6 of this report.

8.5.8.7. Peat probing undertaken along existing and proposed access tracks and spur roads also showed good correlation with the desk study results. Four sections of existing track (leading to T1, T2, T4 and T9) six sections of new track (N2, N4, N9, N14, N15 & N17) and two spur roads (S13 and S14) are located across areas of identified peat deposits. However, in many cases the extent of the peat is limited to a few isolated probe results and is not widespread. Potential for micro-siting from initially consulted layouts around peat has been assessed and adopted for several of these tracks, however, the peat is unavoidable along some track sections. Full details of micro-siting movements are contained within Annex 8.2 and summarised within Table 3.6 of this report.

8.5.8.8. Peat depth surveys were undertaken at additional infrastructure areas including the northern and southern met masts, substation location options, construction compounds and Borrow pit B. The results show that none of the additional infrastructure components are located within peat deposits (>0.35m deep) with the exception of Borrow Pit B, which was predominately underlain by peat <0.35m deep with the exception of its eastern extreme where some deeper peat was identified. The borrow pit footprint has therefore been reduced to ensure that it is located entirely within peat <0.35m deep. Additional wind farm infrastructure components are therefore not considered further in the assessment of potential loss or degradation of peat.

8.5.8.9. It should be noted that the 2012 updated Phase 1 Habitat Survey and NVC survey (see Chapter 9 Non-Avian Ecology and Annex 9.9 and 9.12 of the ES) did not identify any mire habitat within the Application Site. Mire habitat indicates the presence of underlying peat and includes: blanket bog; raised bog; wet and dry modified bog; acid, neutral or basic flushes; bryophyte dominated spring; and valley, basin and flood plain mires. The lack of mire habitat within the Application Site indicates that, although there may be peat deposits beneath the coniferous plantation forest and beneath the heathland habitat, the Application Site cannot be considered to hold important active peatland habitat (i.e. there are no areas characterised within the survey by their peat-forming vegetation). It is clear that the habitat within the Application Site has been highly modified by the planting and management of coniferous trees since the early 20th Century with associated impacts on peat deposits and peat habitat arising from:

- Loss of peat-forming vegetation communities to coniferous forestry plantation;

17 Planting of Clocaenog Forest began in 1905 prior to the creation of the FCW in 1919, who now manage the forest on behalf of the Welsh Assembly Government.
Installation of drainage ditches to drain waterlogged and peaty soils, drying out existing peat deposits and altering the hydrology of the upper soil layers;

Damage to peat deposits from mechanical plant movements during pre-development tree clearance operations;

Application of fertilisers and pesticides, modifying plant communities beneath the forest canopy and along roadside verges; and

Construction of forest roads through existing peat deposits, altering their hydrological connectivity and fragmenting deposits.

8.5.8.10. It is therefore considered that peat deposits within the Application Site have already been significantly degraded by long term and on-going forestry operations, and that there are no areas of active peatland habitat within the Application Site. It is recognised, however, that there may be potential to restore parts of the Application Site with existing underlying peat deposits to active bog and these areas of the site should be considered as sensitive receptors. Given the sensitive nature of areas to be restored and the importance of peat in terms of potential for carbon loss, a conservative approach has been adopted over the remaining areas of peat across the site and all identified peat deposits across the Application Site have been classified as Regional / Medium sensitivity.

8.5.9. Geology

Drift Geology

8.5.9.1. The superficial geology of the Application Site is shown in Figure 8.2.

8.5.9.2. The majority of the Application Site is underlain by glacial tills (boulder clay) of unknown thickness, while the higher parts of the Application Site (e.g. around Craig Bron-banog, Foel Frech and Foel Goch) have no superficial deposits. Alluvial sediments are found to the south of the Application Site along the Nant y Ffridd, River Clwyd and River Alwen valley floors, and to the north along the Afon Clywedog and Afon Corris valley floors. Localised deposits of peat occur along the valley of Nant Llyfarddu and in smaller pockets across the north and west of the Application Site. The total area of peat within the Application Site is estimated to be at least 52 ha, based on the BGS mapped peat deposits. Peat deposits are discussed in greater detail in section 8.5.8.

Solid Geology

8.5.9.3. The underlying solid geology of the Application Site is shown in Figure 8.3

8.5.9.4. The south of the Application Site is underlain predominantly by deposits of the Denbigh Grits Formation, ranging in thickness between 750 and 1,500 m. This formation comprises graptolitic mudstones, siltstones, sandstones, mature grits and conglomerates. A number of faults are observed to cross the south of the Application Site with a southeast to northwest trend, sloping down to the northeast. A series of shorter faults cross the summit of Craig Bron-banog in a northeast to south westerly direction.

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18 Mudstones with evidence of the tube-like marine organisms, Graptolites.
8.5.9.5. The north of the Application Site is largely underlain by deposits of the Upper Nantglyn Flags Group, up to 650 m in thickness. This comprises regularly alternating thin mudstones and graptolitic muddy siltstones and laterally extensive Upper and Lower Mottled Mudstone beds. The far north of the Application Site is underlain by undifferentiated mudstone, siltstone and sandstone of the Elwy Formation. A number of faults cross the north of the Application Site, trending southwest to northeast, and sloping downwards to the northwest. These faults are interconnected by a number of north to south direction faults, sloping downwards to the east.

8.5.9.6. All three rock formations are of Silurian Age (c. 443.7 to 416 million years ago).

Groundwater

8.5.9.7. The majority of the underlying geology has been classified as a non aquifer, i.e. formations which are regarded as containing insignificant quantities of groundwater. However, some non-aquifers can yield water in sufficient quantities for domestic use and provide base flow to rivers.

8.5.9.8. The sandstone within the Denbigh Grits Formation, which outcrops at Craig Bron-banog in the south of the site, has been classified as a secondary aquifer. The areas of alluvium in the south of the site are also classified as a minor aquifer.

8.5.9.9. Minor aquifers are locally important and potentially capable of supporting local, small to medium groundwater abstractions. Such aquifers may also be significant in providing base flow to surface waters. It is therefore considered that the minor aquifers are of medium sensitivity in the context of this assessment.

8.5.9.10. There are no groundwater Source Protection Zones (SPZs) within the Application Site. Groundwater abstractions are considered separately in Section 8.4.19.

8.5.9.11. The groundwater environment is considered to have a Regional / Medium sensitivity to impact from the Project.

8.5.10. Fisheries

8.5.10.1. The Afon Clwyd is an important salmon and sea trout fishery. Salmon are able to migrate throughout most of this river system and may be present within the Application Site. The Bontuchel Weir on the Afon Clywedog, 7.5 km downstream from the Application Site, formerly prevented upstream migration of fish. However, a fish pass was constructed by EAW in 2004 to allow fish access to the 19km of spawning grounds upstream of the weir. Three impassable barriers to fish migration were identified during the site visit within the Application Site: at Clywedog Reservoir; on the Aber Terfyn watercourse downstream from T10; and at crossing F on an unnamed tributary of Oernant (see Figure 8.1). It is therefore assumed that salmon and sea trout will be present in the watercourses downstream from these barriers. No migratory fish will be present upstream from these barriers. Clywedog Reservoir is stocked by rainbow trout for fishing, managed by the Llanidloes and District Angling Association, and used by other local angling associations.

Chapter 8: Hydrology and Geology

8.5.10.2. The River Dee, downstream from the Alwen catchment, is a nationally important salmon fishery and is part of a SAC designated in part for its populations of Atlantic salmon (see Section 8.5.7 for further details). The River Dee and its tributaries also hold populations of brown trout, sea trout and grayling, and game fishing takes place on the Afon Alwen. Llyn Brenig Reservoir, to the west of the site, is stocked with 36,000 rainbow trout and is one of the best fly-fishing lakes in the UK. Llyn Brenig dam presents a barrier to fish migration, therefore it is assumed that migratory salmon and sea trout are present in the watercourses downstream from the reservoir (Afon Alwen catchments 2, 3, 4 and 5) but not upstream (Afon Alwen catchment 1).

8.5.10.3. Classification of these rivers is therefore of High Importance.

8.5.11. Private Water Supplies

8.5.11.1. A separate assessment of private water supplies (PWS) has been undertaken by SKM Enviros and the findings of this assessment are contained in Annex 8.5. In summary, the review of supplies in close proximity to the Project identified 85 PWS sources within a 2 km search radius of the Application Site red line boundary. Due to the number of PWS considered by this report, a tiered risk assessment process was designed to screen risk to receptors over three stages. The first two levels of assessment are qualitative, with a final semi-quantitative assessment of risk for PWS identified with potential for impact from the development proposals. The existing methodology was confirmed with Denbighshire County Council and Conwy County Borough Council prior to commencing the assessment. Further details regarding this consultation are provided within the Consultation Report which accompanies the DCO application.

8.5.11.2. Classification of Private Water Supplies is considered to be of High Importance.

8.5.12. Licensed Abstractions and Discharge Consents

8.5.12.1. In Wales there is a legal requirement for water abstractions greater than 20 m$^3$/day to be licensed. Therefore, the records of water abstraction within 2 km of the Application Site red line boundary have been acquired from the EAW.

8.5.12.2. Data provided by EAW indicates there are several licensed water abstractions located within 2 km of the Application Site. High level summary information on these abstractions is provided in Table 8.12.

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21 http://www.hiraethog.org.uk/content.php?nID=20&lID=1
22 Information provided by the EA on 18th November 2008.
Table 8.12 Licensed Water Abstractions within 2 km of Application Site red line boundary

<table>
<thead>
<tr>
<th>Reference Number</th>
<th>Distance and Direction from Application Site red line boundary</th>
<th>Catchment Area</th>
<th>Source</th>
<th>Abstraction Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>1 – 2 km south</td>
<td>Afon Alwen 4</td>
<td>Surface watercourse – Nant y Derwydd</td>
<td>Hydroelectric Power Generation</td>
</tr>
<tr>
<td>A2</td>
<td>&gt;2 km west</td>
<td>Downstream from Afon Alwen 1</td>
<td>Llyn Brenig Reservoir</td>
<td>Water supply and transfer Project to augment the summer flow of the River Dee downstream</td>
</tr>
<tr>
<td>A3</td>
<td>&gt;2 km west</td>
<td>Downstream from Afon Alwen 1</td>
<td>Surface watercourse – Afon Brenig</td>
<td>Fish farm / cress pond throughflow</td>
</tr>
<tr>
<td>A4</td>
<td>&gt;2 km east</td>
<td>Downstream from Afon Clywedog</td>
<td>Surface watercourse – Afon Clywedog</td>
<td>Hydroelectric Power Generation</td>
</tr>
<tr>
<td>A5</td>
<td>&gt;2 km south</td>
<td>Downstream from Afon Alwen catchments 1 to 5</td>
<td>Surface watercourse – Afon Alwen</td>
<td>Fish farm / cress pond throughflow</td>
</tr>
<tr>
<td>A6</td>
<td>&gt;2 km north west</td>
<td>No catchment connectivity with the Project</td>
<td>Llyn Bran Reservoir</td>
<td>Public water supply</td>
</tr>
<tr>
<td>A7</td>
<td>&gt;2 km south east</td>
<td>No catchment connectivity with the Project</td>
<td>Spring</td>
<td>General washing/ process washing</td>
</tr>
<tr>
<td>A8</td>
<td>&gt;2 km south east</td>
<td>No catchment connectivity with the Project</td>
<td>Spring</td>
<td>General washing/ process washing</td>
</tr>
<tr>
<td>A9</td>
<td>&gt;2 km west</td>
<td>No catchment connectivity with the Project</td>
<td>Alwen reservoir</td>
<td>Public Water Supply</td>
</tr>
<tr>
<td>A10</td>
<td>&gt;2 km west</td>
<td>No catchment connectivity with the Project</td>
<td>Surface watercourse – unnamed stream</td>
<td>Transfer for water supply</td>
</tr>
</tbody>
</table>

8.5.12.3. Abstractions A1 to A5 are located downstream from the Application Site and are in hydrological connectivity with the Project. As such they are considered to be sensitive receptors to the Project. Abstractions A6 to A10 are not in hydrological connectivity with the Project and are therefore not considered further within this ES.

8.5.12.4. The importance of the site in relation to public abstractions and discharges is considered to be Medium.

8.5.13. Baseline Sensitivity

8.5.13.1. Table 8.13 summarises the importance assigned to the various receptors discussed in the sections above.
Table 8.13 Summary of Site Resource Sensitivities

<table>
<thead>
<tr>
<th>Resource</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water Quality – Afon Clwyd Catchment</td>
<td>Regional / Medium</td>
</tr>
<tr>
<td>Surface Water Quality – Afon Alwen Catchment</td>
<td>Regional / Medium</td>
</tr>
<tr>
<td>Water Dependant Designated Sites</td>
<td>National / High</td>
</tr>
<tr>
<td>Flood Risk</td>
<td>Local / Low</td>
</tr>
<tr>
<td>Peat Resource</td>
<td>Regional / Medium</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Regional / Medium</td>
</tr>
<tr>
<td>Private Water supplies</td>
<td>High</td>
</tr>
<tr>
<td>Fisheries – Salmon / Trout</td>
<td>High</td>
</tr>
<tr>
<td>Licensed Abstractions</td>
<td>Medium</td>
</tr>
</tbody>
</table>

8.6. Predicted Impacts

8.6.1. This section provides a summary of the potential effects of the Project, based on an assessment of activities that will occur during the pre-development tree clearance, construction and operational phases of the Project, prior to the inclusion of mitigation measures (see Table 8.14, Table 8.15 and Table 8.16). Assessment of potential impacts does not include consideration of design requirements as this process is considered to be part of the mitigation process and is detailed as contribution to this within the assessment tables under the Design Requirement column. Potential effects during the decommissioning phase are deemed the same as those during construction.
### Table 8.14 Potential Impacts During the Pre-development Tree Clearance Phase

<table>
<thead>
<tr>
<th>Activity</th>
<th>Potential impact</th>
<th>Magnitude of potential impact</th>
<th>Sensitivity of receptor</th>
<th>Evaluation of Impact Significance</th>
<th>Duration of Impact</th>
<th>Design Requirement</th>
<th>Need for Mitigation</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-development tree clearance</td>
<td>Increase in runoff leading to enhanced erosion of newly exposed soil, including exposed peat material</td>
<td>Medium</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Short Term</td>
<td>×</td>
<td>✓</td>
<td>Impacts associated specifically with forestry pre-development tree clearance operations are considered within Chapter 7 (Land Use and Forestry) – pre-development tree clearance will be undertaken by FCW on behalf of RWE NRL. EAW will be consulted in advance of wind farm construction works.</td>
</tr>
<tr>
<td></td>
<td>Generation of turbid and nutrient rich runoff which could enter adjacent drains and watercourses: affecting downstream receptors including fish stocks and PWS.</td>
<td>Medium</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Short Term</td>
<td>×</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spillages and leakages of oil, fuel, and other potentially polluting substances which could potentially enter downstream watercourses</td>
<td>Low</td>
<td>Regional / Medium</td>
<td>Minor</td>
<td>Medium Term</td>
<td>×</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
### Table 8.15 Potential Impacts During the Construction Phase

<table>
<thead>
<tr>
<th>Activity</th>
<th>Potential impact</th>
<th>Magnitude of potential impact</th>
<th>Sensitivity of receptor</th>
<th>Evaluation of Impact Significance</th>
<th>Duration of Impact</th>
<th>Design Requirement</th>
<th>Need for Mitigation</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of additional access tracks</td>
<td>Changes or disruption to surface water runoff patterns which could result in a flooding risk</td>
<td>Low</td>
<td>Local / Low</td>
<td>Not significant</td>
<td>Long Term</td>
<td>✓</td>
<td>×</td>
<td>No mitigation required - Good practice track drainage provisions to be part of the access track design.</td>
</tr>
<tr>
<td>Generation of turbid runoff which could enter adjacent drains and watercourses ultimately polluting Afon Clwyd, Afon Alwen and the River Dee.</td>
<td>Medium</td>
<td>National / High</td>
<td>Moderate</td>
<td>Short Term</td>
<td>✓</td>
<td>✓</td>
<td>Trackside drains with the potential to carry high sediment loads will be designed to discharge into a silt trap or buffer area of adequate capacity to prevent direct discharge into downstream watercourses, drains or local ponds.</td>
<td></td>
</tr>
<tr>
<td>Generation of turbid and nutrient rich runoff which could enter adjacent drains and watercourses polluting local water supplies or fisheries</td>
<td>High</td>
<td>National / High</td>
<td>High</td>
<td>Short Term</td>
<td>✓</td>
<td>✓</td>
<td>Mitigation measures adopted to manage risk to downstream sensitive watercourses will however protect surface water features. PWS are assessed in detail within Annex 8.5</td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td>Potential impact</td>
<td>Magnitude of potential impact</td>
<td>Sensitivity of receptor</td>
<td>Evaluation of Impact Significance</td>
<td>Duration of Impact</td>
<td>Design Requirement</td>
<td>Need for Mitigation</td>
<td>Comment</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------</td>
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<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Upgrades to drain or watercourse crossings</td>
<td>Generation of turbid runoff which could enter the drainage network and pollute downstream watercourses.</td>
<td>Medium</td>
<td>National / High</td>
<td>Moderate</td>
<td>Short Term</td>
<td>✓</td>
<td>✓</td>
<td>No additional watercourse or drain crossings are required. All crossing points will be assessed prior to development for suitability. Where crossings need to be upgraded mitigation is needed to prevent impacts to downstream watercourses. Drainage with the potential to carry high sediment loads will not be allowed to discharge directly to watercourses but will discharge into a silt trap or buffer area of adequate capacity.</td>
</tr>
<tr>
<td>Spillages of concrete during foundation formation, which could enter</td>
<td></td>
<td>Medium</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Short Term</td>
<td>✓</td>
<td>✓</td>
<td>Use of precast concrete for all culvert crossings will remove the risk of concrete pollution to watercourses.</td>
</tr>
<tr>
<td>local watercourses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disruption to peat hydrology due to excavation of access tracks</td>
<td></td>
<td>Medium</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Long Term</td>
<td>✓</td>
<td>✓</td>
<td>Mitigation required reducing impacts to hydrology of adjacent peat during track construction operations.</td>
</tr>
<tr>
<td>Wind turbine foundations and crane pads</td>
<td>Spillages of concrete during foundation formation, which could enter local watercourses or impact underlying groundwater resources/PWS</td>
<td>Medium</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Medium Term</td>
<td>✓</td>
<td>✓</td>
<td>Mitigation is required to control concrete pouring activities. In the event of pollution an Emergency Response Plan (ERP) outline provided in Annex 3.1 will be used. PWS are assessed within Annex 8.5</td>
</tr>
<tr>
<td>Activity</td>
<td>Potential impact</td>
<td>Magnitude of potential impact</td>
<td>Sensitivity of receptor</td>
<td>Evaluation of Impact Significance</td>
<td>Duration of Impact</td>
<td>Design Requirement</td>
<td>Need for Mitigation</td>
<td>Comment</td>
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</tr>
<tr>
<td></td>
<td>Potential discharge of groundwater following dewatering that has elevated suspended sediments, which could enter local or downstream watercourses/PWS</td>
<td>Medium</td>
<td>National / High</td>
<td>Moderate</td>
<td>Short Term</td>
<td>✓</td>
<td>✓</td>
<td>If dewatering is required during excavation of the turbines, dewatering fluids will be directed into surface silt traps to ensure sediment does not enter the surrounding water features. PWS are assessed within Annex 8.5</td>
</tr>
<tr>
<td></td>
<td>Disruption to peat hydrology due to dewatering of turbine excavations</td>
<td>Medium</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Long Term</td>
<td>✓</td>
<td>✓</td>
<td>Mitigation required reducing impacts to hydrology of adjacent peat during foundation operations.</td>
</tr>
<tr>
<td></td>
<td>Grid connection and electric cables</td>
<td>Trenches could act as small drainage channels and lead to turbid water entering adjacent local and downstream watercourses through alteration of local runoff</td>
<td>Medium</td>
<td>National / High</td>
<td>Moderate</td>
<td>Short Term</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Substation, Control Building, construction and enabling works for compounds and spillages and leakages of oil, fuel, and other potentially polluting substances which could potentially enter adjacent or downstream watercourses/PWS</td>
<td>Low</td>
<td>National / High</td>
<td>Moderate</td>
<td>Medium Term</td>
<td>×</td>
<td>✓</td>
<td>Good site management practices will be adopted to reduce the potential for any spillages or leakages of potentially polluting substances. PWS are assessed within Annex 8.5</td>
</tr>
<tr>
<td>Activity</td>
<td>Potential impact</td>
<td>Magnitude of potential impact</td>
<td>Sensitivity of receptor</td>
<td>Evaluation of Impact Significance</td>
<td>Duration of Impact</td>
<td>Design Requirement</td>
<td>Need for Mitigation</td>
<td>Comment</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------</td>
<td>----------------------------------</td>
<td>--------------------</td>
<td>-------------------</td>
<td>---------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>temporary laydown area</td>
<td>Changes in surface water runoff patterns due to creation of hardstanding areas which could result in a flooding risk</td>
<td>Low</td>
<td>Local / Low</td>
<td>Not significant</td>
<td>Long Term</td>
<td>✓</td>
<td>×</td>
<td>No mitigation required - Sustainable Drainage System (SUDS) design philosophy will be followed (in Annex 8.1).</td>
</tr>
<tr>
<td>Site activities</td>
<td>Spillages and leakages of oil, fuel, and other potentially polluting substances e.g. concrete which could migrate into soil and groundwater and potentially enter adjacent or downstream watercourses</td>
<td>Medium</td>
<td>National / High</td>
<td>Major</td>
<td>Medium Term</td>
<td>×</td>
<td>✓</td>
<td>Standard practice requires the storage of materials within protective bunding of sufficient capacity to contain all spillages (PPG2). Compliance with standard practice will be outlined within the Construction Method Statement (CMS) and supporting annexes (see Annex 3.1).</td>
</tr>
</tbody>
</table>
### Table 8.16 Potential Impacts During the Operational Phase

<table>
<thead>
<tr>
<th>Activity</th>
<th>Potential impact</th>
<th>Magnitude of potential impact</th>
<th>Sensitivity of receptor</th>
<th>Evaluation of Impact Significance</th>
<th>Duration of impact</th>
<th>Design Requirement</th>
<th>Need for Mitigation</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Tracks</td>
<td>Changes in surface water runoff patterns which could change flooding risk</td>
<td>Low</td>
<td>Local / Low</td>
<td>Not significant</td>
<td>Long Term</td>
<td>✓</td>
<td>×</td>
<td>No mitigation required - good practice track drainage provisions to be part of the access track design. On-going wind farm maintenance to ensure appropriate site drainage.</td>
</tr>
<tr>
<td></td>
<td>Increased surface water runoff during periods of higher than normal rainfall intensity could change flood risk</td>
<td>Low</td>
<td>Local / Low</td>
<td>Not significant</td>
<td>Long Term</td>
<td>✓</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Generation of turbid runoff which could enter adjacent drains or downstream watercourses ultimately polluting Afon Clwyd, Afon Alwen and the River Dee.</td>
<td>Medium</td>
<td>National / High</td>
<td>Moderate</td>
<td>Short Term</td>
<td>✓</td>
<td>✓</td>
<td>Good site management practices will be adopted to ensure suspended sediments within runoff are controlled.</td>
</tr>
<tr>
<td></td>
<td>Vehicular movement generating turbid runoff which could enter adjacent watercourses polluting local water supplies or fisheries</td>
<td>High</td>
<td>National / High</td>
<td>High</td>
<td>Short Term</td>
<td>✓</td>
<td>✓</td>
<td>Mitigation measures adopted to manage risk to downstream sensitive watercourses will protect surface water features.</td>
</tr>
</tbody>
</table>

PWS are assessed within Annex 8.5
<table>
<thead>
<tr>
<th>Activity</th>
<th>Potential impact</th>
<th>Magnitude of potential impact</th>
<th>Sensitivity of receptor</th>
<th>Evaluation of Impact Significance</th>
<th>Duration of impact</th>
<th>Design Requirement</th>
<th>Need for Mitigation</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substation, Control Building and Compound</td>
<td>Spillages and leakages of oil, fuel, and other potentially polluting substances which could potentially enter adjacent or downstream watercourses/PWS</td>
<td>Low</td>
<td>National / High</td>
<td>Moderate</td>
<td>Medium Term</td>
<td>×</td>
<td>✓</td>
<td>The Construction Environmental Management Plan (CEMP), outline provided in Annex 3.1, and good site management practices will be adopted to reduce the potential for any spillages or leakages of potentially polluting substances. PWS are assessed within Annex 8.5</td>
</tr>
<tr>
<td>Changes in surface water runoff patterns which could change flooding risk</td>
<td>Low</td>
<td>Local / Low</td>
<td>Not significant</td>
<td>Long Term</td>
<td>✓</td>
<td>×</td>
<td></td>
<td>No mitigation required - good practice drainage provisions to be part of the wind farm design. Indicative drainage design is provided in Annex 8.1. On-going wind farm maintenance to ensure appropriate site drainage.</td>
</tr>
<tr>
<td>Increased surface water runoff during periods of higher than normal could change flood risk</td>
<td>Low</td>
<td>Local / Low</td>
<td>Not significant</td>
<td>Long Term</td>
<td>✓</td>
<td>×</td>
<td></td>
<td>Re-establishment of vegetation cover over some deforested areas leading to a gradual reduction in peak runoff rates.</td>
</tr>
<tr>
<td>Land use change</td>
<td>Reducing runoff due to re-establishment of vegetation cover</td>
<td>Low</td>
<td>Local / Low</td>
<td>Not significant</td>
<td>Long Term</td>
<td>×</td>
<td>×</td>
<td>Re-establishment of vegetation cover over some deforested areas leading to a gradual reduction in peak runoff rates.</td>
</tr>
<tr>
<td>Site activities</td>
<td>Spillages and leakages of oil, fuel, and other potentially polluting substances which could migrate into soil and groundwater and potentially enter downstream watercourses/PWS</td>
<td>High</td>
<td>Regional / Medium</td>
<td>Major</td>
<td>Medium Term</td>
<td>×</td>
<td>✓</td>
<td>Good site management practices would be adopted to reduce the potential for any spillages or leakages of potentially polluting substances. PWS are assessed within Annex 8.5</td>
</tr>
</tbody>
</table>


8.7. Mitigation

8.7.1. Mitigation measures to protect the water environment have been incorporated into the design of the Project as well as into the construction methods. Measures will prevent or reduce potential impacts both during construction and once the wind farm is operational. It is expected that details will be subject to agreement with the local authority in consultation with EAW / CCW and FCW. Full details of all mitigation and enhancement proposed for the project are included within Chapter 16 (Mitigation and Enhancement).

8.7.2. Where prevention and reduction measures have not been possible, mitigation measures will be utilised to offset significant effects. These measures are described below for the pre-development tree clearance, construction, operation and decommissioning phases of the project.

8.7.1. Design Requirements

8.7.1.1. The general approach used has been to avoid any potential effects as part of the wind farm design process. This includes providing buffer zones around watercourses where activities can be avoided, using suitable water resistant construction materials, ensuring site drainage provisions for wind farm infrastructure does not significantly alter existing runoff regimes and avoiding drainage channel crossings where possible. Significant measures have also been taken during the design process to avoid areas of deep peat.

8.7.1.2. Where avoidance measures have not been possible, precautionary mitigation measures have been utilised, preventing any significant effects occurring. These measures are described below for the pre-development tree clearance, construction, operation and decommissioning phases of the project.

8.7.2. Pre-development Tree Clearance

Forestry Operations

8.7.2.1. Pre-development tree clearance operations related to the development of the wind farm will result in changes to the runoff regimes across this area. In particular the removal of trees will reduce rainfall interception and evapotranspiration rates, leading to a possible increase in runoff and consequently higher peak flows within surface water streams or drainage channels. Increase in stream flow has the potential to increase flood risk. Pre-development tree clearance to facilitate the development of the wind farm is detailed within the FCW's Forest Design Plan.
8.7.2.2. Research into changes of runoff due to pre-development tree clearance within forestry plantations does not currently provide sufficient information to accurately predict increases in downstream flows. However there is general consensus within hydrological literature that the presence of forestry plantations has little effect on flooding resulting from more extreme events such as the 10% Annual Exceedance Probability (AEP) or 2% AEP. Under such conditions it is anticipated that the interception capacity of the forest canopy will become exhausted23. Forestry plantations are therefore likely to influence only smaller magnitude flood events. The proposed Surface Water Management Plan (SWMP), outline provided in Annex 8.1, will form part of the CEMP (outline provided in Annex 3.1) and will ensure that existing runoff regimes are maintained wherever possible and no increase in peak runoff is experienced within receiving watercourses through use of SUDS and control or runoff through discharge to swales or vegetated buffer areas.

8.7.2.3. Forestry pre-development tree clearance operations will be undertaken by FCW in accordance with the Forestry Commission’s Forests and Climate Change Guidelines24 and the UK Forestry Standard25.

8.7.2.4. Under these measures it is envisaged that sediment erosion and entrainment in runoff can be controlled at least to a level comparable with existing rates of erosion occurring beneath the forest canopy. Potential for turbid runoff to enter watercourses as a result of pre-development tree clearance will be localised and short term only.

8.7.2.5. Operational procedures for forestry harvesting are closely controlled. In order to meet with the requirements of the UK Woodland Assurance Standard (UKWAS) and statutory environmental and health and safety legislation, all FCW harvesting operations are carried out according to FCW best practice procedures laid out in various publications. Specific measures will incorporate consideration of the following.

- Pre-development tree clearance and extraction will be planned to minimise the number of stream and drain crossings required. Where a watercourse crossing is unavoidable, temporary log bridges or pipe crossings will be installed to protect the watercourse and minimise the release of sediments;
- Timber will be stacked in drier areas and outside appropriate buffer zones26 from surface watercourses;
- Long straight fall-line extraction routes will not be used on any steep slopes to prevent the creation of preferential flow paths for sediment laden runoff;
- The use of tracked vehicles on forestry tracks will be avoided to prevent damage and erosion of the track surfaces;
- Where pre-development tree clearance on soft soils or peat deposits is required, an adequate supporting brash mat will be provided and maintained to protect the underlying ground from vehicle movements;

24 UK Forestry Standard Guidelines – Forests and Climate Change (2011)
26 Minimum buffers of 20m (for watercourses over 2m wide) and 10m (for watercourses less than 2m wide) will be applied, in line with guidance in the Forestry Commission (2003); Forests and Water Guidelines 4th Edition
Local watercourses will be inspected regularly for evidence of discoloration or sediment deposition originating from harvesting sites. Any pollution sources will be traced and appropriate remedial measures put in place to prevent further pollution; Brash will be stored away from watercourses to prevent organic pollution; and The location of any underground water pipes (e.g. for PWS) will be identified and protected from pre-development tree clearance operations.

8.7.3. Construction

Access Tracks

8.7.3.1. The onsite track layout is illustrated in Figure 8.1. The track layout is designed to minimise land take and avoid key environmental receptors, including watercourses and areas of deep peat. The majority of the development utilises existing access tracks, incorporating these existing access tracks into the Project layout being upgraded as appropriate.

8.7.3.2. The Clocaenog Wind Farm Peat Depth Survey Report (Annex 8.2) discusses in further detail areas of the site requiring mitigation measures for development on peat. Handling of peat during construction is also discussed below.

8.7.3.3. The depth of peat does not warrant the use of floating roads, and therefore all new tracks will be of conventional 'cut' road design which requires the excavation of topsoil to a depth no greater than 1 m. Excavated material will be replaced with a suitable fill to form a stable embankment founded directly on the mineral soils or bedrock beneath the peat. The top layer of fill is typically made up of up to 500 mm of compacted granular stone over a permeable geotextile liner. Trackside drainage will be provided and tracks will have a camber to encourage the runoff of track drainage. The trackside drainage will comprise either buffer strips or infiltration trenches. There will be no direct discharge of construction drainage to existing watercourses. Further details relating to design of the cut tracks are contained in Chapter 3 (Project Description).

8.7.3.4. To limit potential impacts of hardcore and excavated material entering watercourses or sediment levels increasing within surface water runoff, the contractors engaged for construction of the Project will be required to adhere to a CEMP (outline provided in Annex 3.1) during construction activities. The CEMP will be developed to control the risk of pollution and sediment and will be agreed with EAW prior to the start of the site works and will be held within the CMS (outline provided in Annex 3.1). Both of these documents are presented in outline form in Annex 3.1. Measures to be incorporated within the CEMP include recommendations for storage of excavated soil/peat from new access tracks or access tracks to be upgraded. All storage of soil will be away from any identified watercourse or drain. Measures will also include the routine working and emergency procedures for the control and mitigation of erosion and dust generation during excavations and soil handling.

8.7.3.5. Construction of access tracks and their continued use during the construction phase may potentially generate turbid runoff. Measures described in EAW PPG notes, CIRIA guidance and Forest and Water Guidelines will be formalised within the CEMP (outline provided in Annex 3.1) and the contractors will be required to comply with this document. Management of surface water runoff will be required during the construction phase and will be part of the overall site drainage plan as outlined in the CEMP. Trackside drains with the potential to convey entrained sediments within runoff will discharge into a swale...
or buffer area of adequate capacity to prevent discharge directly into any watercourse, drain or water body. The potential for turbid runoff to enter watercourses will be localised and short term only.

8.7.3.6. Where possible, access tracks have been located a minimum distance of 50 m from main drainage channels and watercourses.

**Watercourse Crossings**

8.7.3.7. Current proposals do not require additional watercourse or drain crossings to be constructed, however, assessment of existing crossings will be made as part of the detailed design of the wind farm. Where crossings are deemed inappropriate and require upgrade, including widening to accommodate the required track width, they will be designed and constructed in accordance with EAW and CIRIA good practice guidance and will be agreed in advance with EAW. Culverts will be sized to pass the 1% Annual Exceedence Probability (AEP) flow, including an allowance for climate change on future rainfall intensities. Design of these crossings will take into consideration overland flow routing in the event of a blockage and will be designed to direct flow back into the watercourse downstream of any obstruction.

8.7.3.8. The impacts of the crossings on the drainage channels will be lessened by minimising the disruption to the banks. The use of cofferdams and over-pumping will be considered if the drainage channels to be crossed exhibit potential for high flows during the construction period.

8.7.3.9. The construction of any drainage channel crossing will be bound by the protocols of the CMS to avoid polluting watercourses with soil or sediment.

8.7.3.10. Water quality will be tested prior to works commencing in order to ascertain the baseline conditions. Further testing will then be completed during and after the construction of watercourse / drain crossings. Water Quality will be tested upstream and downstream of any construction works so that the impact of the works can be determined. Any programme of water testing will be included within the SWMP. Potential for turbid runoff to enter watercourses will be controlled and limited through measures set out in the SWMP and will be localised and short term only.

**Wind Turbine Foundations and Crane Hardstandings**

8.7.3.11. Details of the wind turbine foundations are contained within Chapter 3 (Project Description). Turbines are to be supported on concrete foundations, the depth of which will be dictated by the depth of superficial deposits overlying bedrock at each proposed turbine site (maximum excavation depth of 3.5 m). Excavations will be formed with sides 'battered' back to ensure that they remain stable during construction.

8.7.3.12. A series of manmade drainage channels and various natural drains exist across the Application Site. These features generally drain the site in a north-easterly, southerly and south-westerly direction towards the Afon Clwyd, Afon Alwen and River Dee and their tributaries. Wind turbines and associated crane hardstandings have been located a minimum distance of 50 m away from the main drainage channels. Micro-siting assessment and options maintained the integrity of this buffer to open watercourses and no movement of turbines encroach into the buffer zone. Minimum requirement for buffers
of 20 m (for watercourses over 2 m wide) and 10 m (for watercourses less than 2 m wide), in line with Forestry Commission Forest and Water Guidelines\textsuperscript{27} have been met.

8.7.3.13. The Peat Depth Survey Report (Annex 8.2) field survey results have identified that six turbine locations (T2, T4, T10, T11, T13 and T29) are located either partly or completely within peat deposits over 0.35 m thick. Micro-siting has reduced the impact on peat >0.35m in some of these locations. Of the remaining turbines T19 has only been partially surveyed due to the dense forestry cover. The results that were obtained generally indicated that peat is between 0.10 m and 0.90 m in depth at this location. Micro-siting of this turbine has been assessed and the position has been amended to locate the turbine on peat <0.35m depth. The probing results from all other turbine locations indicate the average peat depth is less than 0.35 m.

8.7.3.14. Calculations of the total area of peat that will be lost or degraded as a result of construction of these turbines and associated crane hardstanding areas are presented in Section 3.3 of the peat report (Annex 8.2).

8.7.3.15. Turbine foundations will be formed through the pouring of concrete. Concrete is highly alkaline and corrosive and can have a detrimental impact on watercourses. Without controls on this process, concrete spillages could potentially result in pollutants coming into contact with local groundwater and surface water features. Concrete will be brought to the Application Site ready mixed, temporary bunds will be placed around pouring operations to contain spillages and a spill response protocol will be developed for use by contractors and will be detailed within the CMS (outline provided in Annex 3.1). The preference will be for all vehicle washouts to take place off-site. Any drainage or water used for on-site washing will need to be collected and directed to a sump located in a suitably lined and contained area for treatment prior to discharge. Any discharge will be in agreement with EAW or in accordance with EAW discharge licensing conditions.

8.7.3.16. Temporary bunds will be placed around pouring operations to contain spillages and an Emergency Response Plan (ERP), outline provided in Annex 3.1, will be developed for use by contractors as part of the CEMP (outline provided in Annex 3.1). As specified within the CEMP, appropriate equipment and materials for containing and neutralising spills will be held on-site. Prior to pouring of concrete within turbine excavations, the degree of weathering or fracturing of bedrock will be assessed. It may be necessary to form a barrier within the excavation to ensure liquid concrete does not come into contact with underlying strata and groundwater. Either a geotextile liner or a sand layer would line the excavation in order to restrict the flow of concrete into the surrounding groundwater. This would only be necessary if there was evidence of significant fracturing which could give rise to a potential for vertical groundwater flow. This will be determined by an intrusive ground investigation prior to works commencing.

**Electric Cables**

8.7.3.17. The electric cables for the Project will be installed within small trenches (approximately 1 m deep and 3.6 m wide) that will run alongside the access tracks. Where possible, they will be dug during dry weather conditions to prevent runoff. Profiling of the peat removed in excavating the cable trenches will be maintained to ensure that the peat can be restored once the cables are in place. The cables will be placed within a sand sub base.

\textsuperscript{27} UK Forestry Standard Guidelines – Forests and Water (2011)
Peat will be replaced as quickly as possible to avoid these trenches becoming drainage pathways. Clay or other appropriate soils will be used as an impermeable barrier at intervals along each trench to ensure the excavations do not become preferential flow paths and thus changing land drainage regimes.

Substation Compounds and Control Buildings

8.7.3.18. There will be one substation building and associated compound within the Application Site. The substation compound and associated equipment will have a total footprint of 68 m by 60 m and be surrounded by security fencing. This includes a single storey control building of 4m by 15 m by 3 m (length by width by height), within a substation compound area of approximately 50m by 50m.

8.7.3.19. Indicative flood mapping provided by EAW shows both substation compound options to be completely within an area with a low risk of fluvial inundation. However, regard for risk is required within the design including the use of suitable water resistant construction materials. Since the footprint is small, the damage to soil resources will be minimal and, other than adopting good practice measures for handling soils, no further precautionary mitigation is required.

8.7.3.20. Both of the substation compound options are located away from all main watercourses and waterbodies adjacent to the existing forest tracks. Rainfall runoff from the substation will be managed through discharge to infiltration drains or other SUDS techniques, appropriate for the scale of the substation development. Full details of the substation drainage design will be outlined within the SWMP.

Construction Compounds and Site Activities

8.7.3.21. Two temporary construction compounds (50m x 50m) will form part of the development, one will be located adjacent to the access track southeast of Turbine 30 within the south of the Application Site, and one to the north of the site, north east of turbine T1. The construction compound area will be designed in the same way as described above for the access tracks, using crushed and compacted granular stone and will be restored after construction. This will provide a reduction in peak surface water flows and aid infiltration across the area. Some areas of hardstanding within the compound will be required for storage of oils or other pollutants and as a base for refuelling of equipment.

8.7.3.22. The compound locations are away from all main watercourses and waterbodies. However, as with the turbine bases, any surface water runoff from the construction compound will be managed through discharge to ground through the permeable surface cover, or managed using other SUDS techniques such as infiltration drains. A surface water management plan (SWMP) will include details of surface water management for the site (including the construction compound) and is presented in Annex 8.1 of this ES. It will be prepared in full prior to commencement of the Project. This plan will assess the requirement for any attenuation of surface water runoff from the compound and will promote attenuation solutions to control runoff where required.

8.7.3.23. As noted above, the storage of oils and other potentially polluting substances will be within the construction compound. Storage will be within impervious storage bunds with 110 % capacity, so that any spillages or leaks are contained.

8.7.3.24. Construction machinery will be checked regularly. Any maintenance required would occur over hard standing within the construction compound or on an alternative suitable
impermeable ground cover. Drip trays will be mandatory beneath all stationary construction vehicles and spill kits comprising absorbent mats or absorbent sands will be available on-site at all times. All relevant staff will be trained in their appropriate use. Any spills will be cleaned up as soon as possible with any contaminated sands bagged up and disposed of correctly. All procedures will be outlined within the CEMP and ERP (outlines provided in Annex 3.1).

8.7.3.25. Throughout the construction phase good working practices will be adopted and measures to protect the water environment will be incorporated in accordance with those set out within EAW PPG notes. Adherence to this best practice guidance will ensure minimal risk to receiving environments from development of the construction compound and general site activities.

Private Water Supplies

8.7.3.26. Given the potential risk to PWS from the construction of the Project, an assessment of risk to PWS has been undertaken. Reporting for this assessment is contained in Annex 8.5, however a summary of PWS considered being potentially at risk are detailed in Table 8.17.

8.7.3.27. A total of 13 PWS supplies providing water to 15 properties or end users were identified as potentially being at risk, for Tier 3 assessment. Of these assessments, 7 of the properties have primary domestic supplies which do not have potential to be impacted by the Project, however a secondary property supply for livestock exists which does require mitigation to ensure integrity of the supply. Specific mitigation measures for these supplies are discussed in detail within Annex 8.5.

* Table 8.17 Private Water Supplies*

<table>
<thead>
<tr>
<th>Property or end user</th>
<th>Type of supply</th>
<th>Location</th>
<th>Comment</th>
<th>Mitigation required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bron Bannog</td>
<td>Borehole</td>
<td>303210, 352820</td>
<td>Domestic supply</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>302880, 352820</td>
<td>Former domestic supply. Location refers to holding tank fed by upstream springs in forest. Other springs to south feed stream on land to south, used for livestock.</td>
<td>Yes</td>
</tr>
<tr>
<td>Bryn Bach</td>
<td>Stream</td>
<td>301880, 359080</td>
<td>Abstraction to holding tank on tributary of Afon Concwest. Water then piped to the two properties. Only source or supply to each property.</td>
<td>Yes</td>
</tr>
<tr>
<td>Bryn Bach Bungalow</td>
<td>Stream</td>
<td>301880, 359080</td>
<td>Abstraction to holding tank on tributary of Afon Concwest. Water then piped to the two properties. Only source or supply to each property.</td>
<td>Yes</td>
</tr>
<tr>
<td>Cefn Bannog</td>
<td>Stream</td>
<td>302269, 351176</td>
<td>Spring fed stream from forest feeds holding tank above property. Only source or supply to property.</td>
<td>Yes</td>
</tr>
<tr>
<td>Cruglas</td>
<td>Spring</td>
<td>302789, 353815</td>
<td>Spring fed holding tank at edge of forestry which is used for domestic supply. Nant Llyfarddu stream from forestry area flows through Cruglas property landholding and is used for livestock watering</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Stream</td>
<td>302590, 353775</td>
<td>Spring fed holding tank at edge of forestry which is used for domestic supply. Nant Llyfarddu stream from forestry area flows through Cruglas property landholding and is used for livestock watering</td>
<td>Yes</td>
</tr>
<tr>
<td>Property or end user</td>
<td>Type of supply</td>
<td>Location</td>
<td>Comment</td>
<td>Mitigation required?</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------</td>
<td>----------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Crud y Gwynt Spring</td>
<td>Spring</td>
<td>302425, 354575</td>
<td>Spring emerges into a shallow covered holding tank within forestry approximately 280m upgradient of properties. Spring provides domestic supply.</td>
<td>Yes</td>
</tr>
<tr>
<td>Nilig Stream 302095, 354905</td>
<td>Stream</td>
<td>302095, 354905</td>
<td>Small stream from forestry area flows through property landholding and is used for livestock watering</td>
<td>Yes</td>
</tr>
<tr>
<td>Diffwys Spring 302570, 357719</td>
<td>Spring</td>
<td>302570, 357719</td>
<td>Spring emerges from cut rockface on access drive to property. Flow passes to holding tank adjacent to track, upgradient of property. Spring provides domestic supply.</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Stream</td>
<td>302095, 354905</td>
<td>Afon Clywedog flows from Clywedog reservoir, within forestry area approximately 1,150 m upstream of Diffwys landholding. Stream flow is used for livestock watering.</td>
<td>Yes</td>
</tr>
<tr>
<td>Pant Dedwydd Stream 301224, 350015</td>
<td>Stream</td>
<td>301224, 350015</td>
<td>Nant Y Wrack stream abstraction within southern boundary of forestry land. Water is used for livestock purposes only – no domestic use.</td>
<td>Yes</td>
</tr>
<tr>
<td>Tal y Cefn Isaf Stream/ Spring 299605, 352048</td>
<td>Stream/Spring</td>
<td>299605, 352048</td>
<td>Stream and spring fed tank located in forest uphill from the two properties. Tank supply piped to properties.</td>
<td>Yes</td>
</tr>
<tr>
<td>Yr Hen Ysgubor Borehole a. 304172, 353158 b. 304173, 353002</td>
<td>Borehole</td>
<td>302350, 356175</td>
<td>Borehole adjacent to property provides domestic supply. Stream tributary of Orenant flows from forestry area through Trawsnant landholding, providing water for livestock use.</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Stream 302310, 356202</td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Trawsnant Borehole</td>
<td>Borehole</td>
<td>a. 304172, 353158</td>
<td>Borehole supply to main farmhouse located in rear garden area for domestic use. Second borehole recently installed for development work to south of property for domestic use.</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>b. 304173, 353002</td>
<td></td>
<td>Tributary of Afon Clwyd rises within forestry and flows through Waen Ganol landholding, providing water for livestock.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Stream 303975, 353063</td>
<td></td>
<td>Spring located to the north east of the farmhouse for livestock use.</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Spring 304300, 353228</td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Waen Uchaf Spring 303870, 354002</td>
<td>Spring</td>
<td>303870, 354002</td>
<td>Spring adjacent to road feeds large open holding tank within forestry to north of property. Source for domestic use.</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Stream 303454, 353192</td>
<td></td>
<td>Tributary of Afon Clwyd rises within forestry and flows through Waen Ganol</td>
<td>Yes</td>
</tr>
<tr>
<td>Property or end user</td>
<td>Type of supply</td>
<td>Location</td>
<td>Comment</td>
<td>Mitigation required?</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------</td>
<td>----------</td>
<td>---------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Glan Cierw</td>
<td>Borehole</td>
<td>302774, 355837</td>
<td>Deep borehole for domestic supply to property</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Stream</td>
<td>302833, 355882</td>
<td>Oernant watercourse passes adjacent to property and is abstracted for livestock use.</td>
<td>Yes</td>
</tr>
</tbody>
</table>

8.7.3.28. The domestic spring supply for Crud y Gwynt and Nilig has been assessed from a hydrogeological perspective and recommendations made for control of sediment which could impact on springs from surface runoff. Mitigation including sediment traps will be required around construction activities, including borrow pit B when extraction is commencing and turbine bases during construction to reduce the likelihood of sediment entrainment. Sediment control activities will be detailed within the detailed SWMP. The potential for fuel or oil spills to contaminate the shallow aquifer supplying these springs will be managed through good site practices and the ERP (Annex 3.1 provides an outline), as detailed in the proposed mitigation for construction compounds above.

8.7.3.29. The two stream supplies for domestic use at Cefn Bannog and Bryn Bach/Bryn Bach Bungalow have been assessed to determine risk to upstream reaches of surface watercourses providing supply to these PWS. Mitigation measures including sediment traps will be required around construction activities, including borrow pit C which has potential for surface runoff connectivity with the catchment supplying Cefn Bannog and the northern substation compound which has potential for surface runoff to the catchment supplying the PWS for properties at Bryn Bach. Sediment control activities will be detailed within the SWMP. The potential for fuel or oil spills to contaminate watercourses will be managed through good site practices and a the ERP (Annex 3.1 provides an outline), also detailed within the CMS (outline provided in Annex 3.1).

8.7.3.30. Properties at Tal y Cefn Isaf and Yr Hen Ysgubor are supplied by a common source which is a spring and stream supply to a storage tank in forestry above the properties. Wind farm infrastructure is remote from the spring supply however is potentially within the catchment for surface water and mitigation measures to control sediment entrainment will be required to protect this supply.

8.7.3.31. The supplies identified for livestock watering are either streams or spring fed streams originating from the Application Site or surrounding area, with a potential direct runoff pathway for sediment entrainment to these supplies. Upstream reaches of several of these watercourses are crossed by existing track crossings which will be used for the Project and could potentially be upgraded as part of these works. Mitigation measures for Watercourse Crossing covered in Section 8.5.1 will ensure integrity of reaches downstream of any crossing point. Sediment controls and site drainage plans, as set out within the SWMP and CMS (outline provided in Annex 3.1) for other construction activities, will ensure no sediments entrained in surface runoff directly enter surface watercourses. This will provide protection to downstream reaches, which are used for livestock watering.
Water Quality Monitoring

8.7.3.32. A water quality monitoring programme will form part of the SWMP and CMS (outline provided in Annex 3.1) and will assess the on-going quality of the watercourses throughout the construction period. Water quality monitoring will be undertaken prior to any works on-site commencing in order to ascertain the baseline conditions. Baseline monitoring should take place over several months to establish a robust baseline for quality and quantities. Monitoring will be undertaken at key watercourse locations as detailed within the SWMP and CMS. Frequent monitoring during the construction and early operational phases will be checked against the benchmark baseline data to confirm both quality and quantity is maintained.

8.7.3.33. An appropriate monitoring regime for the 13 PWS with potential to be impacted by the proposed development will be agreed with Conwy County Borough Council and Denbighshire County Council, in consultation with the Environment Agency Wales, prior to commencement of construction works. Residents or users supplied by PWS to be monitored will be consulted prior to commencement of construction to inform them of the works that will be undertaken and how their water supplies will be safeguarded during the construction phase.

8.7.3.34. An ECoW will oversee the monitoring programme during construction, which will include regular inspections of the Application Site drainage and natural watercourses to ensure that sediment and debris do not accumulate and present a risk to downstream water supplies. Regular liaison with EAW will be carried out during the construction process.

8.7.3.35. Regular liaison with EAW will be carried out during the construction. Work will be carried out in accordance with the requirements and procedures outlined in current legislation, with Environmental Permits obtained from EAW as necessary.

Borrow Pits

8.7.3.36. Four borrow pits (A, B, C, and D) will be developed across the Application Site. Locations of the 4 borrow pits are detailed on Figures 3.1a/b/c and also Figure 8.1. Selection of the borrow pit locations has been informed by reporting contained in Annex 8.6: Methodology and Reasons for Choosing Mineral Sites.

8.7.3.37. Initial activities will include the removal of topsoil in order to expose the bedrock for extraction. As with the development of the haul road outlined above, measures will be defined within a CMS (outline provided in Annex 3.1) and SPMP regarding the management and storage of removed soil to control the risk of pollution and sediment. Any storage of soil will be away from drains and watercourses, and stockpiles will be located and battered so as to limit instability and erosion. Silt fences and mats will be used to minimise sediment levels in runoff from the stockpiles.

8.7.3.38. Measures will also include the routine working and emergency procedures for the control and mitigation of erosion and dust generation during excavations and soil handling. Temporary interception bunds and drainage ditches will be constructed upslope of the borrow pit to minimise ingress of surface runoff. These ditches will be of minimum length, depth and gradient required to be effective; silt traps and buffer strips will be used to minimise erosion, sedimentation and peak flows. All interception bunds and drainage ditches will be fully reinstated once extraction from the borrow pit is completed. Surface water runoff within the borrow pit area will be routed to settlement ponds detailed within the detailed drainage design. Measures defined within the SWMP and CMS (outline
provided in Annex 3.1) will control runoff and restrict the possibility for sediment to become entrained within local watercourses. The likelihood of occurrence is considered to be Low following mitigation.

8.7.3.39. Activities will include the continued removal of topsoil in order to expose the bedrock for extraction and measures to manage this process will be as defined within the construction phase, outlined above. Extraction activity will be through blasting and mechanical extraction which is likely to generate dust and fine particles which will have the potential to become entrained sediment within runoff. Surface water runoff from areas of extraction activity will be routed to settlement ponds. Discharge from the pond systems will be to ground infiltration or vegetated buffer areas through agreement with EAW.

8.7.3.40. Extraction of bedrock is typically to a level of 3 m bgl (below ground level), depending on ground conditions. This is likely to be below the prevailing groundwater table. Groundwater inflows to the excavation areas will be managed through pumping to the settlement pond system. Groundwater inflows will be controlled largely by the transmissivity of the aquifer (i.e. permeability and aquifer thickness).

8.7.3.41. There will be no direct discharge of runoff from the borrow pit areas to surrounding watercourses. Measures defined within the CMS (outline provided in Annex 3.1) and SWMP will control runoff and restrict the possibility for sediment to become entrained within local watercourses.

Peat Restoration

8.7.3.42. Proposed reinstatement of the peat habitat is described within the OHMP contained in Annex 9.10. Four areas have been identified as potentially suitable for peatland restoration based on available desk based information sources (including both BGS drift geology maps and FCW soil survey maps) and previous site walkovers. Three of these potential restoration areas were suggested by CCW in their consultation response on 16th July 2010, and a further area, outside the Application Site, but within Clocaenog Forest, was suggested by FCW.

8.7.3.43. These four potential restoration areas include:

- Management of the Gors y Wern area could ensure maintenance/potential enhancement of c.2.5ha of peatland habitat.
- The area south of Turbine 4 is potentially suitable for restoration of up to 9ha of peatland mire habitat.
- The area between Turbines 22 and 26 is considered to be potentially suitable for restoration of up to 26ha of peatland mire habitat.
- It is considered that the wider, eastern area north of Tai’n-y-Graig would be potentially suitable for restoration of up to 8.6ha of peatland mire habitat.

8.7.3.44. In addition, three other potential restoration areas have been identified for consideration as a result of the intrusive peat surveys. These are:

- The area to the west of T11
- The area to the south of T13
- The area to the north west and west of T29
8.7.3.45. Four of the seven areas identified have been assessed as suitable for inclusion as potential restoration areas, namely:

- Gors y Wern (1.8ha);
- area south of Turbine 4 (6.9ha);
- area between Turbines 22 and 26 (15.8ha); and
- area to the west of T11 (0.9ha).

8.7.3.46. Restoration proposals will include infill or damming of drainage channels in order to raise peat wetness and increase the groundwater levels within the peat body returning it to a more natural state. Further details are provided in the OHMP (Annex 9.10).

**Peat Excavation**

8.7.3.47. Alteration in peat structure can impact the surrounding hydrological environment and changes to the peat hydrology are expected to occur due to the construction of tracks and through excavation of peat at turbine bases, however, the Project layout has been designed to avoid peat deposits wherever possible. Specific measures will be adopted for the handling, storage and management of any peat excavated for the access tracks, turbine and crane pad foundations. The CMS (outline provided in Annex 3.1) will detail the exact construction methodology to be used for each specific foundation location, taking into account:

- The method of excavation and the location for placing and storing excavated material to ensure that these operations do not give rise to slope or site instability;
- Surface vegetated scrags / turves will be laid out and stored, for re-sodding bare areas, and watered in dry weather; and
- Details of how excavated materials will be prevented from falling onto the adjacent peatland surface in areas other than designated as safe side-cast or stockpile zones.

8.7.3.48. Measures to be adopted for the handling, storage and management of excavated peat, where possible, include:

- Avoidance of stockpiles where possible. Any temporary stockpiles will be located and battered so as to limit instability and erosion;
- Silt fences and mats will be employed to limit sediment levels in runoff from temporary stockpiles;
- Temporary stockpiles will be located away from watercourses;
- Any bunding of peat disposal areas will have bunds that extend to a level above the toe of the spoil to provide resistance to runoff;
- Any water discharged from peat excavations or stockpiles will be monitored as part of the water quality monitoring outlined in the SWMP; and
- Where bunding is not used, peat will be spread in a thin layer over a large area.

8.7.3.49. Assessment of impact on peat from construction activity has taken into consideration the potential effect of drainage to peat areas surrounding these activities, should they have a
dewatering effect. Draw down of groundwater within peat can result in a reduction in the level of wetness which can subsequently affect peat structure.

8.7.3.50. Peat excavated will be reused on-site and significant long term stockpiling will be avoided where possible. Most of the stored peat will be re-used around the turbine bases and crane hardstanding foundations, with any remaining peat being used for peat habitat restoration purposes. A temporary shallow peat stockpile will be constructed within which the peat can be stored. For deeper peat deposits, the excavation will ensure that the top vegetation and fibrous layers are kept separate from the deeper humic peat. When storing peat, the peat profile will be maintained. These peat stores will be bunded using impermeable material (most likely soils sourced from non-peat soil turbine excavations). The bunds will extend to a level above the toe of the stockpiled material to provide restraint to surface runoff. A Soil and Peat Management Plan (SPMP) will be prepared to ensure soil disturbance is minimised. Following implementation of the strategy, residual effects on soil will not be significant.

8.7.3.51. Historical and on-going forestry activities across the site has substantially modified the peat through activities such as tree planting, installation of drainage and deep ploughing. The structure of the peat and its ability to store water is already impacted and is unlikely to be further affected by the majority of construction works, except for excavations in areas where peat depth is >0.35m. The design process has looked to locate infrastructure away from areas of peat >0.35m in depth.

8.7.3.52. A full review of peat depth across the site is contained within Annex 8.2: Peat Depth Survey Report which also discusses the potential for peat instability, concluding that the risk is low and no further works in respect of peat slide risk assessment is considered necessary.

8.7.4. Operation

8.7.4.1. This section describes the mitigation measures that will be incorporated into the Project to reduce impacts on the water environment and soil during the operational phase. Apart from the general maintenance of the turbines, there will be few on-site activities during the operational phase of the Project. However, the Project has the potential to affect the water environment throughout its operation; therefore, a long-term strategy for sustainable mitigation has been developed.

Access Tracks including Watercourse Crossings

8.7.4.2. The design of the access tracks outlined within Chapter 3 (Project Description) and Section 8.7 above describe how surface water will be managed, and this is also applicable to the operational phase. However, routine maintenance of the tracks will help to further reduce potential for increased suspended sediment levels within nearby drains and watercourses. The proposed track design is largely utilising existing forestry tracks, with additional new spur tracks to turbine locations. The tracks will be in place for the life of the Project and only limited maintenance is envisaged for the track network during the operation of the Application Site. Following decommissioning, forestry tracks will remain, however spur tracks may be removed.

8.7.4.3. Access tracks will be finished with a camber to ensure that drainage is shed to avoid erosion of track surfaces and turbid water generation. As during the construction phase, small infiltration drains, flow attenuation measures or vegetated buffer strips adjacent to the tracks will ensure that any runoff is adequately controlled in terms of quality and
quantity. There will be no direct discharge into any drainage channel or watercourses as
the runoff rates will be relatively small and the use of buffer zones and/or soakaways will
ensure that runoff filters into surrounding vegetation. The track drainage design will
ensure that runoff rates are not increased and will be sized to accommodate runoff flows
for the life of the Project, taking into account increases in peak rainfall intensity due to
climate change. Drainage provisions beneath access tracks that run perpendicular to
slopes will ensure continuity of surface water flows to downslope catchments. An
indicative drainage design is presented within Annex 8.4 Flood Consequence
Assessment (FCA).

8.7.4.4. Routine maintenance of the access tracks will include for the checking of all watercourse
crossings for evidence of blockage. If any blockages are identified, remedial action will
be required to reinstate the full capacity of the crossing point.

Substation Compounds and Control Buildings

8.7.4.5. The electrical substation and control buildings will be designed in accordance with good
practice, which will ensure that there is no potential for leaks or pollution incidences from
the building. The building will also be subject to routine checks and maintenance.

8.7.4.6. The small quantity of sewage arising from the infrequent visits of maintenance staff will
be stored in a septic tank and removed periodically by a licensed contractor. A rainwater
collection system would be installed to provide water for flushing which, if necessary,
would be topped up with water brought to site in containers.

8.7.4.7. Excess rainwater falling on the roof of the building will be discharged to an infiltration
drain or other SUDS based drainage system around the substation. The building will not
be of a size to intercept significant quantities of water and no impact is expected on the
underlying hydrogeology or hydrology of the site.

Wind Turbine Foundations and Crane Hardstandings

8.7.4.8. The turbines would be designed with fluid catch basins and containment systems to
prevent accidental releases from leaving the nacelle. Any accidental gear oil or other
fluid leaks from the wind turbines would be contained inside the towers as they are
sealed around the base, with the entrance situated above ground level. Any spillage or
leaks would be cleaned up once detected.

8.7.4.9. Turbine foundations will lie up to 3.5 m below the natural ground level and will be re-
instated so that the finished footprint will comprise only the tower and crane hardstanding
and access path. Reinstatement of the turbine foundation area will comprise back filling
the foundation area over the subsurface foundations with excavated peat and re-
vegetating to allow for the natural infiltration of surface water.

8.7.4.10. Turbine foundations will be constructed using sulphate resistant concrete, which means
they will not degrade when in contact with acidic water.

Land Use Change

8.7.4.11. The potential impacts and proposed mitigation to control the adverse impacts of forestry
plantation removal have been discussed under the section of this Chapter which relates
to the construction phase and within Chapter 7(Land Use and Forestry). The mitigation
measures adopted during the construction phase will continue through to the operational
phase. It is expected that any increase in runoff following the clearance of trees will reduce as the site re-vegetates and the peat soils begin to stabilise following wind farm construction. Studies show this to be the case\textsuperscript{28}. Details of peat restoration proposals are contained within the OHMP (Appendix 9.9).

8.7.4.12. The increased ground cover vegetation will progressively increase evapotranspiration rates across the Application Site over the early operational period of the wind farm and no further mitigation measures are considered necessary during the operational phase of the Project. Limited maintenance of any drainage features such as infiltration or strip drains may be required over time and will be monitored throughout the operational phase.

Site Activities

8.7.4.13. Routine maintenance of the Project will be undertaken, which will require access to the Application Site by maintenance crews. During such activities, there may be the need to use oils, greases and other substances, leading to the potential for accidental spillages. However, such spillages, if they occur at all, are likely to be very small and since site drainage will be limited, the risk to any downstream watercourse is small. A CEMP (outline provided in Annex 3.1) will be in place in any event to take account of such circumstances during operation of the Project.

8.7.4.14. The Application Site will be operated in accordance with good working practices and measures to protect the water environment in accordance with those set out within EAW PPG notes. All vehicles visiting the Application Site will be equipped with sand trays to place below any oil or fuel filling activities and will be equipped with emergency oil spillage kits.

Private Water Supplies

8.7.4.15. The water quality monitoring programme will continue beyond the construction phase into the early operational stage of the development. The monitoring will continue to assess the on-going quality of the watercourses and selected PWS and will be checked against the benchmark baseline data to confirm both quality and quantity is maintained.

Borrow Pits

8.7.4.16. Restoration of the borrow pit will involve the reworking of exposed rock faces to stabilise them, partial infilling at the base of the pit with surplus material and landscaping with soils excavated during the borrow pit construction and operation. It is considered likely that restoration of the borrow pits will generate a positive impact for the site.

8.7.5. Decommissioning

8.7.5.1. The method of decommissioning of the Project will be agreed with the Local Authorities, both CCBC and DCC and EAW prior to decommissioning.

8.7.5.2. Similar precautionary measures to those proposed for the construction phase will be implemented as necessary, in accordance with good practice at that time. Buried cables or concrete foundations will remain in situ to prevent further land damage. The top 1 m of

the foundation will be removed and covered over with ground cover material and re-vegetated.

8.7.5.3. Access tracks and the watercourse crossing will remain on-site for use by the landowners.

8.8. Residual Effects

8.8.1. This section of the assessment describes the likely residual effects following the incorporation of mitigation measures.

8.8.1. Pre-development Tree Clearance

Residual Effects on Surface Water

8.8.1.1. The SWMP will provide the procedures for the management of surface water detailed within the CEMP (outline provided in Annex 3.1). This plan will ensure that existing runoff regimes are maintained where possible and no increase in peak runoff is experienced within receiving watercourses through use of appropriate control or runoff. Pre-development tree clearance operations will be undertaken by FCW in accordance with the Forestry Commission’s Forests and Climate Change Guidelines and the UK Forestry Standards. Under these measures it is envisaged that sediment erosion and entrainment in runoff can be controlled at least to a level comparable with existing rates of erosion occurring beneath the forest canopy. Potential for turbid runoff to enter watercourses as a result of pre-development tree clearance will be localised and short term only.

8.8.1.2. No significant long-term effect upon the local water environment or downstream sensitive environments or users is predicted. No discernible change in downstream water quality in the Afon Clwyd and Afon Alwen catchments is predicted. Monitoring of water quality will take place prior to and during any pre-development tree clearance activity as part of the water quality monitoring.

Residual Effects on Groundwater

8.8.1.3. Control of runoff to surface water features through a SWMP, as detailed above, will reduce the potential for groundwater effects from spillages and leaks from pre-development tree clearance machinery. The likelihood of such events is low as would be the magnitude of such an occurrence. Therefore, it is considered that any effect would not be significant. With the application of appropriate mitigation measures as discussed in this Chapter it is assessed that there will be no significant residual effects on groundwater.

Residual Effects on Private Water Supplies

8.8.1.4. Proposed mitigation measures are considered to be suitable for protecting surface water and groundwater quality during pre-development tree clearance activities. The importance of PWS to properties is recognised and the location of any PWS infrastructure will be identified and protected from pre-development tree clearance operations. Annex 8.5 contains details of all PWS sources within hydraulic continuity to the site. Mitigation measures will protect these supplies during pre-development tree clearance activities, ensuring that likelihood and the potential magnitude of risk are reduced, resulting in residual risks being Minor.
8.8.1.5. Monitoring will ensure integrity of supply is maintained and in the unlikely event of impact being noted through the monitoring process, will highlight the need for remediation to restore the supply to baseline conditions. If long term disruption to any PWS is noted, an alternative supply will need to be provided by the developer.

Effects on Soil including Peat

8.8.1.6. Best working practices will be followed to ensure that the soil erosion potential is kept to a minimum. Activities will be undertaken in line with Forestry and Water guidelines and it is not expected that there will be any significant increase in erosion of soils, including peat. Tracked vehicles will be used during the pre-development tree clearance process and where pre-development tree clearance on soft soils or peat deposits, an adequate supporting brash mat will be provided and maintained to protect the underlying ground from vehicle movements.

8.8.1.7. A Soil and Peat Management Plan (SPMP) will be prepared to ensure soil disturbance is minimised. Following implementation of the strategy, residual effects on soil will not be significant.

8.8.2. Construction

Residual Effects on Surface Water

8.8.2.1. The magnitude of changes to surface water runoff is predicted to be minimal with the introduction of a SWMP\(^29\) to continue draining the Application Site and facilitate construction. This Plan will be designed to mimic current runoff processes. Surface water quality will also be protected through measures formalised within the SWMP and the requirement for all contractors to adhere to it.

8.8.2.2. The SWMP will provide measures to protect against sustained excessive sediment runoff into local drainage channels and watercourses. It is anticipated that during the construction phase there is potential for an increase in sediment loading within runoff from the Application Site. This is however predicted to be a short duration impact only, occurring during periods of high intensity rainfall. As such, no significant long-term effect upon the local water environment or downstream sensitive environments or users is predicted. No discernible change in downstream water quality in the Afon Clwyd and Afon Alwen catchments is predicted. Monitoring of water quality at strategic locations across the Application Site will take place prior to and during any construction activity as part of a water quality monitoring plan which will be formalised within the SWMP/CEMP (outline provided in Annex 3.1). This will establish a baseline for sensitive watercourses which further monitoring, undertaken at regular intervals throughout the construction and early operational phases, can be benchmarked against.

8.8.2.3. As with any construction project there will be the potential for accidental spillages of pollutants used on-site. Impervious storage bunds are likely to prevent leakage of potential contaminants to nearby surface water features. In the unlikely event of an emergency pollution incident, emergency response procedures will be brought into action from a formalised ERP included within the CEMP (see Annex 3.1 for an outlines). These measures will be in place to reduce the potential of these occurrences and to respond to such occurrences. Therefore, the predicted effects resulting from spillages of oil are not

\(^{29}\) Flood Consequence Assessment (2012) SKM Enviros
considered to be significant and will be temporary in nature. Clywedog Reservoir which is used for fishing is situated over 50 m from any construction activities and the proposed mitigation measures including management of site drainage will ensure this environment is protected. The clearance of trees will result in a short to medium term increase in peak runoff rates, although this increase will be exhibited for low magnitude storm events only. The implementation of a surface water management plan for the site will ensure that runoff regimes are maintained and there will be no significant impact on downstream flooding. For more severe rainfall events, the land use changes will not lead to any significant changes in surface water runoff, and there will therefore be no impact on downstream flood risk for these events.

8.8.2.4. The predicted increase in runoff will, however, result in an increase in stream flows under non-flood conditions. This will be of some benefit to local watercourses during summer months when river flows are generally lower, as increased runoff from the Application Site will help to support baseflow contribution to streams. The benefits of this will be continued support for freshwater ecology within the Afon Alwen and Afon Clwyd and downstream waters.

8.8.2.5. During forestry operations, best working practices will be followed to ensure that the soil erosion potential is kept to a minimum. Activities will be undertaken in line with Forestry and Water guidelines and it is not expected that there will be any significant increase in sediments entering watercourses. Sedimentation rates within any of the waterbodies are therefore not expected to increase. There are no anticipated long term changes to water quality that could lead to changes in the quality of downstream watercourses.

Residual Effects on Groundwater

8.8.2.6. Beneath the site, there is limited potential for groundwater within the underlying bedrock. Measures preventing effects to surface water features will significantly reduce potential for groundwater effects from spillages and leaks. As with surface water, the likelihood of such events is low as would be the magnitude of such an occurrence. Therefore, it is considered that any effect would not be significant.

8.8.2.7. Although piling techniques are not proposed for development of wind farm turbine bases, the EA document *Piling and Penetrative Ground Improvement Methods on Land Affected by contamination: Guidance on Pollution Prevention* (2001) provides good evidence regarding potential effects associated with concrete migration into groundwater. This document considers that migration of concrete would only occur in highly fractured and fast flowing groundwater environments. In addition, the potential for migration of concrete in such groundwater conditions would only occur for a short duration until it begins to set. It is unlikely that such conditions will be encountered on this site and therefore there are no anticipated effects from concrete in groundwater.

8.8.2.8. Measures to control concrete pouring of the turbine foundations and the dewatering or use of geomembrane (where appropriate) to limit groundwater contact with concrete, are likely to significantly restrict any pathway to groundwater. Therefore, it is considered that groundwater quality will not be affected by concrete pouring operations.

8.8.2.9. As with surface water, there is the potential for accidental spillages of oils or other potentially polluting substances to enter groundwater. Measures and protocols will be in place to avoid the likelihood of such events occurring. Therefore, the risks to groundwater are not considered to be significant and will be temporary in nature.
8.8.2.10. Accordingly, with the application of appropriate mitigation measures as discussed in this Chapter it is assessed that there will be no significant residual effects on groundwater.

Residual Effects on Private Water Supplies

8.8.2.11. The mitigation measures proposed for the pre-development tree clearance, construction and operational phases of the Project are considered to be suitable for protecting the water quality upon and surrounding the Application Site. The importance of PWS to properties is recognised and a detailed assessment of potential risk to supplies has been undertaken. This is presented in Annex 8.5 of this report. Proposed mitigation measures will serve to protect these supplies and mean that likelihood and the potential magnitude of risk are reduced, resulting in residual risks being Minor.

8.8.2.12. The PWS identified within Table 8.17 have been identified as being potentially at risk and will be included within the proposed monitoring plan. Monitoring will ensure integrity of supply is maintained and in the unlikely event of impact being noted through the monitoring process, will highlight the need for remediation to restore the supply to baseline conditions. If long term disruption to any PWS is noted, an alternative supply will need to be provided by the developer.

Residual Effects on Soil including Peat

8.8.2.13. A Soil Handling Plan (SHP) will be prepared to ensure soil disturbance is minimised. Following implementation of the strategy, residual effects on soil will not be significant. This will form part of the detailed CEMP (outline provided in Annex 3.1) and will be prepared pre-construction once the Principal Contractor has been appointed.

8.8.2.14. Alteration in peat structure can impact the surrounding hydrological environment and changes to the peat hydrology are expected to occur due to the construction of tracks and through excavation of peat at turbine bases, however, the Project layout has been designed to avoid peat deposits wherever possible. Calculations have included for areas of peat directly impacted by construction activity and have also taken into consideration the potential effect of drainage to peat areas surrounding construction activities should they have a dewatering effect. Drainage can result in a reduction in the level of wetness within peat deposits, which can affect peat structure. However, the peat on this site has already been substantially modified by forestry activities such as tree planting, installation of drainage and deep ploughing. As such, the peat structure and its ability to store water has already been impacted and is unlikely to be further affected by the majority of construction works, except for deep excavations in areas where peat depth is >0.35m. Notwithstanding this, the peat loss calculations have included for a maximum drainage extent of 10m.

8.8.2.15. The total loss of peat resulting from construction of the wind farm has been calculated to be an area of 14.89ha, with an underlying volume of peat loss of 77,165m³, based on consideration of peat areas >0.35m in depth only. Following consultation with CCW consideration has been given to peat loss for all identified peat areas, including areas where peat depth is <0.35m. Inclusion of the top 0.35m of the ground results in a significant increase in both the area and the volume of peat lost as a result of the scheme. It is considered that this total volume of 209,373m³ represents the worst case scenario for the peat loss calculations.

8.8.2.16. Calculations have also been undertaken for the areas and volumes identified at peat restoration sites and for the four restoration areas considered for taking forward as part of
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SKM Enviros

the development, the restoration potential in terms of volume is 280,655m³. This
represents an increase of 34% in restored peat by volume to that lost as a result of the
scheme. All peat loss calculations are detailed within Annex 8.2 Clocaenog Wind Farm
Peat Depth Survey.

8.8.3. Operation

Residual Effects on Surface Water

8.8.3.1. Design of the development will be such that runoff rates will not be increased during
rainfall events. Surface water runoff from developed areas of the Application Site will
pass to the proposed drainage systems and wherever possible infiltrate to ground or the
surrounding peat body. Excess flows during extreme events will also mimic existing runoff
regimes and pass overland, following local topography to local watercourses and
drainage channels, in the same way as existing runoff. Successful habitat and peat
restoration will also ensure no increase in peak runoff from the Application Site and that
erosion of soil or peat does not occur.

8.8.3.2. As runoff from the development will be managed locally by infiltration, there will be no
anticipated increase in flows to local watercourses. Consequently there is no anticipated
impact from the Project on existing hydraulic regimes and no increased risk of increased
flooding on receptors beyond the site boundary.

8.8.3.3. There will be no significant changes to the surface water regime during the operation of
the Project. The drainage provision for access tracks will ensure that changes to water
quality or runoff is minimised as far as is reasonably possible. Activities on-site will be
infrequent and therefore the risk of accidental spillages entering surface watercourses is
remote. Since the likelihood of such events is low and strict procedures will be in place to
deal with any such instances, it is considered that any impact would not be significant.

Residual Effects on Groundwater

8.8.3.4. There are no predicted significant effects on groundwater quality during the operation of
the Project. The concrete bases of the turbines do not represent a risk to groundwater
once constructed as they will be made using a sulphate resistant concrete. This
composition means they will not degrade when in contact with acidic water.

Residual Effects on Private Water Supplies

8.8.3.5. The water quality monitoring programme will continue into the early operational stage of
the development. The monitoring will continue to assess the on-going quality of the
watercourses and selected PWS and will be checked against the benchmark baseline
data to confirm both quality and quantity is maintained. The residual risk to PWS during
the operational phase is not considered to be significant.

Residual Effects on Soil including Peat

8.8.3.6. Whilst no effects are predicted on the water environment, the progressive restoration of
peat soils in line with the OHMP is a beneficial effect of the development. Changes to the
peat hydrology will need to be continually monitored to ensure that the measures put in
place remain effective. With the measures outlined and a programme of continual
monitoring and maintenance, if required, the changes to the peat habitat will be moderate and positive in nature.

8.8.4. **Decommissioning**

**Residual Effects on Surface Water**

8.8.4.1. The drainage provision for the access tracks will remain throughout decommissioning to ensure that there are no water quality issues or runoff changes. Decommissioning activities onsite will be controlled and good practice will be maintained, ensuring the risk of accidental spillages entering surface watercourses remains remote. The same pollution prevention controls as implemented during the construction process will apply to decommissioning and this will ensure that the predicted residual effects will be not significant.

**Residual Effects on Groundwater**

8.8.4.2. The turbine foundations will remain in situ after decommissioning and therefore there are no predicted significant effects on groundwater quality during the decommissioning of the Project. The concrete bases of the turbines do not represent a risk to groundwater once constructed as they are made using a sulphate resistant concrete. This composition means they will not degrade when in contact with acidic water.

**Residual Effects on Private Water Supplies**

8.8.4.3. Contractors will adhere to mitigation measures similar to those included within the operation stages of the development for any decommissioning works on site. All decommissioning works will be subject to a decommissioning method statement, which may include for monitoring of PWS.

**Residual Effects on Soil including Peat**

8.8.4.4. No effects are predicted during decommissioning as all above ground infrastructure including turbines, control buildings and substations will be removed using the established tracks. Much of the track infrastructure and below ground foundations will remain in situ and therefore there will be no further excavation activity.

8.9. **Evaluation of Residual Effects and Conclusions**

8.9.1. Evaluation of the significance residual effects is based on the methodology described in Section 8.1. The results of the evaluation are illustrated in Table 8.18.

8.9.2. The results of this assessment are based on effective mitigation strategies being implemented and that the CEMP (outline provided in Annex 3.1) will be agreed with EAW and the Local Authorities prior to any works commencing.

8.9.3. Residual effects were assessed according to good practice guidance within the EIA Guide to Good Practice and Procedures. Mitigation measures have been developed to address any significant effects associated with the pre-development tree clearance, construction, operation and decommissioning of the Project.
## Table 8.18 Evaluation of the Significance of Residual Effects to the Water Environment

<table>
<thead>
<tr>
<th>Impact</th>
<th>Type of impact</th>
<th>Likelihood of Occurrence</th>
<th>Sensitivity of receptor</th>
<th>Significance of impact</th>
<th>Impact Significance</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-development Tree Clearance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effects on surface water features:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sediment pollution</td>
<td>-ve</td>
<td>Low</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Minor</td>
<td>Potential for short term deterioration in water quality due to pre-development tree clearance.</td>
</tr>
<tr>
<td>Accidental spillages</td>
<td>-ve</td>
<td>Very Low</td>
<td>Regional / Medium</td>
<td>Minor</td>
<td>Not Significant</td>
<td>Pre-development tree clearance operations will be undertaken in accordance with the Forestry Commission’s Forests and Climate Change Guidelines and the UK Forestry Standards. This will include management of surface water runoff. Controls on spillages through good site management practices will be implemented through a CEMP (outline provided in Annex 3.1).</td>
</tr>
<tr>
<td>Deforestation</td>
<td>-ve</td>
<td>High</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Minor</td>
<td>Surface water quality monitoring will be implemented prior to and during pre-development tree clearance activities.</td>
</tr>
<tr>
<td>Effects on PWS</td>
<td>-ve</td>
<td>Low</td>
<td>High</td>
<td>Moderate</td>
<td>Minor</td>
<td>Application of mitigation means the likelihood of any impact on PWS is Low. PWS infrastructure will be located and protected prior to any pre-development tree clearance activity.</td>
</tr>
<tr>
<td>Effects on groundwater features:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accidental spillages</td>
<td>-ve</td>
<td>Very Low</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Minor</td>
<td>Best site management practices adopting EAW guidelines and measures implemented through a CEMP (outline provided in Annex 3.1).</td>
</tr>
</tbody>
</table>
### Impact Significance Ranking

<table>
<thead>
<tr>
<th>Impact</th>
<th>Type of impact</th>
<th>Likelihood of Occurrence</th>
<th>Sensitivity of receptor</th>
<th>Significance of impact</th>
<th>Impact Significance</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on peat:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damage to peat through vehicular access</td>
<td>-ve</td>
<td>Low</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Minor</td>
<td>Control of runoff will be included to ensure that erosion and or drying out of peat are minimised. Good site management practices adopting EAW guidelines and measures implemented through a CEMP (outline provided in Annex 3.1).</td>
</tr>
<tr>
<td>Accidental spillages</td>
<td>-ve</td>
<td>Very Low</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Minor</td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effects on surface water features:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sediment pollution</td>
<td>-ve</td>
<td>Low</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Minor</td>
<td>The use of bunding, oil traps and adhering to good site management practices implemented through a CEMP (outline provided in Annex 3.1). Surface water quality monitoring will be implemented pre, during and post construction and detailed within the CEMP.</td>
</tr>
<tr>
<td>Accidental spillages</td>
<td>-ve</td>
<td>Very Low</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Minor</td>
<td></td>
</tr>
<tr>
<td>Effects on PWS</td>
<td>-ve</td>
<td>Very Low</td>
<td>High</td>
<td>High</td>
<td>Minor</td>
<td>Application of mitigation means the likelihood of any impact on PWS is Very Low however the sensitivity of the receptor dictates that the risk is considered to be Minor for the construction phase.</td>
</tr>
<tr>
<td>Effects on groundwater features:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundation construction</td>
<td>-ve</td>
<td>Low</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Minor</td>
<td>Best site management practices adopting EAW guidelines and measures implemented through a CEMP (outline provided in Annex 3.1).</td>
</tr>
<tr>
<td>Accidental spillages</td>
<td>-ve</td>
<td>Very Low</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Minor</td>
<td></td>
</tr>
</tbody>
</table>
### Impact Significance Ranking

<table>
<thead>
<tr>
<th>Impact</th>
<th>Type of impact</th>
<th>Likelihood of Occurrence</th>
<th>Sensitivity of receptor</th>
<th>Significance of impact</th>
<th>Impact Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on peat: Excavation and replacement</td>
<td>-ve</td>
<td>Low</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Minor</td>
</tr>
<tr>
<td>Peat restoration</td>
<td>+ve</td>
<td>Low</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Minor</td>
</tr>
<tr>
<td>Accidental spillages</td>
<td>-ve</td>
<td>Very Low</td>
<td>Regional / Medium</td>
<td>Minor</td>
<td>Not Significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effects on surface water and groundwater features:</td>
<td>-ve</td>
<td>Very Low</td>
<td>Regional / Medium</td>
<td>Minor</td>
<td>Not Significant</td>
</tr>
<tr>
<td>Accidental spillages</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effects on PWS</td>
<td>-ve</td>
<td>Low</td>
<td>High</td>
<td>Moderate</td>
<td>Minor</td>
</tr>
<tr>
<td>Effects on peat: Peat restoration</td>
<td>+ve</td>
<td>Medium</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

**Rationale**

- Changes are expected to occur with potential track side ponding along floating road sections of track. Drainage provisions will be included to ensure that erosion and or drying out of peat are minimised.
- Design of the wind farm has avoided deep peat where practical. Resulting impact is Minor in relation to the overall peat resource on site.
- Reuse of peat around site and proposed restoration activities represent a positive effect.
- Good site management practices adopting EAW guidelines and measures implemented through a CEMP (outline provided in Annex 3.1).

- The likelihood of any impact on PWS is Low and the potential magnitude of impact during operational phase is also considered to be Low, resulting in a Minor risk.

- Measures put in place and on-going monitoring is expected to ensure that suitable hydrological conditions on the peat deposits are maintained. Improvement to the peat resource across the site following restoration activity will continue throughout the operational life of the Project.
### Decommissioning

<table>
<thead>
<tr>
<th>Impact</th>
<th>Type of impact</th>
<th>Likelihood of Occurrence</th>
<th>Sensitivity of receptor</th>
<th>Significance of impact</th>
<th>Impact Significance Ranking</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on surface water and groundwater features: Accidental spillages</td>
<td>-ve</td>
<td>Very Low</td>
<td>Regional / Medium</td>
<td>Minor</td>
<td>Not Significant</td>
<td>Good site management practices implemented through a CEMP (outline provided in Annex 3.1).</td>
</tr>
<tr>
<td>Effects on PWS</td>
<td>-ve</td>
<td>Low</td>
<td>High</td>
<td>Moderate</td>
<td>Minor</td>
<td>The likelihood of any impact on PWS is Low and the potential magnitude of impact during the decommissioning phase is also considered to be Low due to lack of proposed excavation, resulting in a Minor risk.</td>
</tr>
<tr>
<td>Effects on peat: Peat restoration</td>
<td>+ve</td>
<td>Medium</td>
<td>Regional / Medium</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Improvement to the peat resource across the site following restoration activity will continue beyond the life of the Project.</td>
</tr>
</tbody>
</table>

### Key

<table>
<thead>
<tr>
<th>Type</th>
<th>Likelihood</th>
<th>Sensitivity</th>
<th>Significance</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>-ve = negative</td>
<td>High</td>
<td>International/ High</td>
<td>High</td>
<td>Major</td>
</tr>
<tr>
<td>+ve = positive</td>
<td>Medium</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>National/ High</td>
<td>Minor</td>
<td>Minor</td>
</tr>
<tr>
<td>Very Low</td>
<td>High</td>
<td>Regional/ Medium</td>
<td>Not Significant</td>
<td>Not significant</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium</td>
<td>District/ Medium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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8.10. Cumulative Effects

8.10.1. Figure 1.3 details the location of other wind farms, either operational, under construction or consented or the subject of a planning application, within the study area or within associated hydrological catchments for this assessment. There are two proposed large wind farm developments within 5km of the Project boundary, Derwydd Bach Wind Farm comprising 10 turbines to the south of the site, north of Melin-y-Wig and Brenig Wind Farm comprising 16 turbines to the north west of the site. Both sites are consented. Tir Mostyn and Foel Goch Wind Farms are currently operational to the north and North West of the Project boundary. There are an additional nine single turbine domestic developments (six of which are operational, one consented and two in the planning process), one operational two turbine site and one operational four turbine site within 5km of the Project boundary. The majority of the smaller sites are classed as micro-domestic schemes.

8.10.2. The Brenig site is hydraulically remote from the Development, within the Llyn Brenig catchment. There will be no potential for cumulative impact on hydrological receptors from the Brenig Wind Farm site.

8.10.3. Tir Mostyn and Foel Goch Wind Farms are partially within the upper catchment of Afon Concwest, upstream of proposed construction activity. The north of the wind farm drains to the Afon Ystrad catchment to the north of the Project boundary. The wind farm is well established with no significant effect noted on the hydrological or hydrogeological regimes within this area of the Project boundary. Any decommissioning of the wind farm will be after the proposed construction of Clocaenog Forest Wind Farm. There is not considered to be any potential for cumulative impact from this development.

8.10.4. Derwydd Bach Wind Farm is situated down gradient of the Project boundary, within the Afon Clwyd catchment. The scheme is significant at ten turbines, however, there are no predicted significant effects on the hydrological or hydrogeological environments. There is not considered to be any potential for cumulative impact from this development.

8.10.5. Nant Bach Wind Farm is situated to the south of the Project boundary and to the south of the Afon Alwen. The site is not hydraulically or hydrogeologically connected to the project boundary and as such there will be no potential for cumulative impact on hydrological receptors from this development.

8.10.6. Other single turbine developments are noted to the east of the site at Cae Gwyn, Cae’r Weirglod, Cerrig (two turbines) and Maestyddyn Isa, to the north of the site at Rhiwlas Isa and Wern Uchaf and to the south of the site at Dyfannedd, Wern Ddu (four turbines), Clegir Canol, Cilgoed and Nant y Wrack.

8.10.7. The sites to the east of the Development fall within the Nant Gladur catchment, which rises at Pennant, over 1km from the site boundary. The Nant Gladur catchment is considered to be hydraulically remote from the proposed development and as such there will be no potential for cumulative impact on hydrological receptors from these smaller developments.

8.10.8. The smaller sites to the south of the development are within the Afon Clwyd and Afon Alwen catchments and are likely to be drained by small tributaries to the main channels. Tributaries of the Afon Clwyd and Nant y Wrack which drains to Afon alwen also drain a small area to the south and south east of the Development, including the access corridor, however any potential impact from the Development is significantly upstream of any flows.
entering the watercourse from other development sites. The distance from site combined with the proposed mitigation measures to control sediment during construction and operation of the Development means the potential for cumulative impact on hydrological receptors from these smaller developments is negligible.

8.10.9. There are not considered to be any significant cumulative Effects from the combination of the Project and other developments in terms of hydrology, hydrogeology and geology.

8.11. Conclusions

8.11.1. Overall the residual negative effects of the Project on the water environment following the implementation of mitigation measures are considered Minor, with the effects are generally limited to minor short term changes in surface water runoff, potential for increased sediment loading to runoff, a higher potential for pollution from spillages of substances during construction and decommissioning and changes to peat hydrology.

8.11.2. Effects are generally limited to minor short term changes in surface water runoff, potential for increased sediment loading to runoff, a higher potential for pollution from spillages of substances during construction and decommissioning and changes to peat hydrology.

8.11.3. With the adoption of a comprehensive CEMP (worked up from the outline CEMP submitted as part of the ES submission in Appendix A of Annex 3.1), the development of an OHMP, liaison with the local authority and EAW, and the incorporation of good practice techniques and with the avoidance measures already taken into account in the design of the Project, the changes to the water environment are not predicted to be significant. No cumulative effects with other wind farms will be experienced with respect to the hydrological environment.