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INTRODUCTION

11.1 This Chapter assesses the impacts of the proposed development on the geological environment. The assessment of impacts has been made on the basis of the proposed turbine and infrastructure layout as fully described in Chapter 3: Description of the Development.

11.2 It details the assessment undertaken to determine the potential effects of construction and operation of the proposed development on the current baseline geological regime. It outlines the embedded good practice methods which have been incorporated into the design, and would be used during the construction and operation of the proposed development to prevent or reduce identified effects and risks.

11.3 Further mitigation methods to address any potential effects are proposed, where appropriate, and residual effects assessed.

11.4 This Chapter uses data and information presented in Chapter 11 and associated Technical Appendices to assess potential effects on peat, geology and the effects of previous mining activity on the geological environment.

11.5 In addition the assessment uses information and findings presented in Chapter 9: Ecology to inform the assessment of potential effects on possible areas of peat presented in this Chapter.

11.6 This Chapter should be read in conjunction with Chapter 2: Site Description and Design Evolution, Chapter 5: Environmental Impact Assessment, Chapter 9: Ecology and Chapter 13: Hydrology and Hydrogeology. Planning policies of relevance to this assessment are outlined in Chapter 4: Renewable Energy and Planning Policy.

APPROACH AND METHODS

Study Area

11.7 The ‘study area’ includes the entire proposed Site infrastructure, including significant buffering where relevant to allow for design variation.

Effects Assessed in Full

11.8 The following potential effects have been assessed in full:

- risk to Raven Gill Site of Special Scientific Interest (SSSI) (geological);
- potential effects on geology during both construction and operation, although the nature of the activities during construction and operation of the proposed Development would be unlikely to significantly alter the geology of the Site;
- disruption of historical mining activities, during construction which could lead to mobilisation of mining wastes, via air or water; and
• potential cumulative effects during construction and operation.

Effects Scoped Out

11.9 Impacts to the water environment have been scoped out this Chapter but are discussed in detail in Chapter 13: Hydrology and Hydrogeology.

11.10 Habitat restoration has been scoped out this Chapter but is discussed in detail in Chapter 9: Ecology.

Assessment Structure

11.11 The assessments of both the construction and operational phases have been structured around the consideration of the following potential effects on receptors:

• land slip/landslide instigated by construction and operational activities, particularly related to peat landslide;
• excavation and subsequent deterioration of peat;
• pollution risk: potential effects on surface water and groundwater quality; public and private water supplies;
• erosion and sedimentation: potential effects on surface water as a consequence of disturbing historic mining areas; and
• cumulative effects: potential effects of the proposed development in combination with those from other developments within the study area.

Data Sources and Guidance

11.12 An initial desk study has been undertaken to determine and confirm the baseline characteristics by reviewing available information on geology such including a review of published geological maps, OS maps, aerial photographs and site specific data such as site investigation data, geological and hydrogeological reports and geological literature.

11.13 The following sources of information have been reviewed and assessed:

• British Geological Survey Scotland Sheets 15 – Sanquhar - Solid and Drift Editions, 1870 (S&D), 1937 (S&D), 1950 (D), 1951(S), 1963(S), 1967(S), 1971(S), 1973(S), 1976(S). 1:63,360 series;
• British Geological Survey Scotland – Geology of the Leadhills District;
• The Macaulay Institute for Soil Research Soil Survey of Scotland Sheet 7 – South Eastern Scotland, Land Capability for Agriculture Map. 1:250,000 scale, 1982; and
• BGS Map and Map data viewer (www.bgs.ac.uk/data/mapViewers/home.html)
• Scotland’s Environment portal (www.environment.scotland.gov.uk)
Field Survey

11.14 SLR geologists, hydrogeologists and ecologists have worked closely on this assessment to ensure that appropriate information is gathered to allow a comprehensive impact assessment to be completed.

11.15 Detailed Site visits and walkover surveys have been undertaken by the authors of this assessment on the following dates:

- 30th, 31st March and 4th – 14th April 2016 to identify presence of peat and assess ground conditions.
- 30th & 31st August and 1st and 2nd September 2016 to assess detailed layout of turbines, infrastructure and track layout and areas of historic mining.

11.16 The field work has been undertaken in order to:

- verify the information collected during the desk and baseline study;
- allow appreciation of the Site, determine gradients, access routes, ground conditions, etc., and to assess the relative location of all the components of the proposed development;
- determine extent, morphology and characteristics of peat on Site, detailed in Technical Appendix 11.1 (Peat Landslide Hazard and Risk Assessment);
- determine the extent of peat which may require excavation and management on Site, detailed in Technical Appendix 11.2 (Peat Management Plan);
- determine the suitability of the geological setting to develop borrow pits; and
- determine the geological setting, including a review of historic mining activity and its relationship to the proposed development Technical Appendix 3 (Mining Desk Study Report).

11.17 The desk study and field surveys have been used to identify potential development constraints and have been used as part of the Site iterative design process.

11.18 The data obtained as part of the desk study and collected as part of the field work has been processed and interpreted to complete the impact assessment and recommend mitigation measures where appropriate.
Consultation

11.19 The scope of the desk based study has been determined through a combination of professional judgement, reference to relevant guidance documents and consultation with stakeholders.

11.20 Consultation for the proposed development was undertaken with statutory and non-statutory bodies during 2016 as set out in Chapter 6: Scoping. The outcome of the relevant consultations with regards the geological environment is summarised in Table 11-1.

Table 11-1: Summary of Consultation Responses with Respect to the Geological Environment

<table>
<thead>
<tr>
<th>Consultee</th>
<th>Summary of Consultation</th>
<th>Comment / Action Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadhills Community Council (LCC) (Scoping Phase June 2016)</td>
<td>Concerns raised regarding extent of historic mining activities, and Raven Gill SSSI.</td>
<td>Mining Assessment and Borrow Pit Assessment undertaken and design of windfarm has taken into account these issues and avoided or mitigated where required.</td>
</tr>
<tr>
<td>SEPA (23rd June 2016)</td>
<td>Concerns raised regarding extent of historic mining activities.</td>
<td>A Peat Landslide Hazard and Risk Assessment and a Peat Management. Mining Assessment undertaken.</td>
</tr>
<tr>
<td></td>
<td>Concerns over disturbance and re-use of excavated peat.</td>
<td>A Peat Management Plan has been undertaken for the Site.</td>
</tr>
<tr>
<td></td>
<td>Concerns over use of borrow pits.</td>
<td>A Borrow Pit Assessment has been undertaken for the Site.</td>
</tr>
<tr>
<td>Scottish Natural Heritage (15th July 2016)</td>
<td>SNH identified potential peat lands, with potentially priority peatland habitats.</td>
<td>Design has avoided peat areas where possible and mitigated risk by design in areas where it cannot be avoided.</td>
</tr>
<tr>
<td></td>
<td>Concerns regarding Raven Gill SSSI.</td>
<td>Design of wind farm has avoided SSSI.</td>
</tr>
<tr>
<td>South Lanarkshire Council (15th July 2016)</td>
<td>On sites where peat is known or expected to be present, comprehensive surveys of peat extent and depth should be carried out.</td>
<td>A Peat Landslide Hazard and Risk Assessment and a Peat Management Plan have been undertaken for the Site.</td>
</tr>
</tbody>
</table>

Good Practice Measures and Mitigation

11.21 Any potential effects of the proposed development on the geological environment identified by the assessment have been addressed and mitigated by the Site design and the proposed application of good practice guidance to be implemented as standard during construction and operation
to prevent, reduce or offset effects where possible. As such, a number of measures would form an integral part of the design/construction process and these have been taken into account prior to assessing the likely effects of the proposed development. Where appropriate, further tailored mitigation measures have been identified prior to determining the likely significance of residual effects.

11.22 Prior to construction, site investigation of the route, the infrastructure and the turbines would be undertaken to determine ground risk and mining risk.

11.23 Good practice measures would be applied in relation to pollution risk, sediment management, peat management and management of surface water runoff rates and volumes. This would form part of the draft Construction and Environmental Management Plan (draft CEMP) to be prepared prior to construction and implemented during construction, an outline of which is provided in Technical Appendix 3.1: Draft CEMP.

11.24 As the final CEMP develops it would include details and responsibilities for environmental management onsite for Site environmental aspects and would outline the necessary surface water management measures, oil and chemical delivery and storage requirements, waste management, traffic and transport management and would specify monitoring requirements for waste water, water supply including an Environmental Incident Response Plan (EIRP) and all appropriate method statements and risk assessments for the construction of the proposed development.

Assessing Significance

11.25 The significance of potential effects of the proposed development have been assessed by considering two factors: the sensitivity of the receiving environment and the potential magnitude of impact, should that effect occur.

11.26 The assessment methodology has also been informed by professional experience of carrying out such assessments for a range of wind farm and other developments, knowledge of the geological environment characteristics in Scotland and cognisance of good practice.

11.27 This approach provides a mechanism for identifying the areas where mitigation measures are required and for identifying mitigation measures appropriate to the significance of potential effects presented by the proposed development.

11.28 Criteria for determining the significance of effect are provided in Table 11-2, Table 11-3 and Table 11-4.

Sensitivity

11.29 The sensitivity of the receiving environment (i.e. the baseline quality of the receiving environment) is defined as its ability to absorb an effect without a detectable change and can be considered through a combination of professional judgement and a set of pre-defined criteria which is set out in
Table 11-2. Receptors in the receiving environment only need to meet one of the defined criteria to be categorised at the associated level of sensitivity.

Table 11-2: Criteria for Assessing Sensitivity of Receptor

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Definition</th>
</tr>
</thead>
</table>
| High          | • Receptor is of high geological importance or National or International value (e.g. Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC))  
• Soil type and associated land use is highly sensitive (e.g. unmodified blanket bog peatland).|
| Moderate      | • Soil type and associated land use moderately sensitive to change in geological regime and associated land use (e.g. modified/degraded peat)  
• Historic mining area                                                                 |
| Low           | • Soil type and associated land use not sensitive to change in geological regime and associated land use (e.g. intensive grazing of sheep and cattle) |
| Not Sensitive | • Receptor would not be effected by the proposed development                                                                                 |

Magnitude

11.30 The potential magnitude of impact would depend upon whether the potential effect would cause a fundamental, material or detectable change. In addition, the timing, scale, size and duration of the potential effect resulting from the proposed development are also determining factors. The criteria that have been used to assess the magnitude of impact are defined in Table 11-3.

Table 11-3: Criteria for Assessing Magnitude of Impact

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Criteria</th>
<th>Definitions</th>
</tr>
</thead>
</table>
| Major     | Results in loss of attribute                                             | Fundamental (long term or permanent) changes to the baseline geology such as:  
• permanent degradation and total loss of the soils habitat;  
• loss of important geological structure/features; |
| Medium    | Results in impact on integrity of attribute or loss of part of attribute | Material but non-fundamental and short to medium term changes to baseline geology such as:  
• loss of extensive areas of soils habitat, damage to important geological structures/features; |
| Low       | Results in minor impact on attribute                                     | Detectable but non-material and transitory changes to the baseline geology such as:  
• minor or slight loss of soils or slight damage to geological structures / feature; |
| Negligible| Results in an impact on attribute but of insufficient magnitude to affect the use/integrity | No perceptible changes to the baseline geology such as:  
• no impact or alteration to existing important geological environs; |
Significance of Effect

11.31 The sensitivity of the receiving environment together with the magnitude of the impact determines the significance of the effect, which can be categorised into levels of significance as identified in Table 11-4. This also takes into account good practice measures implemented and embedded as part of the design and construction of the proposed development and use of professional judgement where appropriate.

11.32 Table 11-4 provides a guide to assist in decision making. However, it should not be considered as a substitute for professional judgment and interpretation. In some cases, the potential sensitivity of the receiving environment or the magnitude of potential impact cannot be quantified with certainty and therefore professional judgement remains the most robust method for identifying the predicted significance of a potential effect.

11.33 The characteristics of the impacts are described in terms of direct / indirect, temporary (revisable) / permanent (irreversible), together with timescales (short, medium, long term).

Table 11-4: Significance of Effect

<table>
<thead>
<tr>
<th>Magnitude of Impact</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Major</td>
<td>Major</td>
</tr>
<tr>
<td>Medium</td>
<td>Moderate</td>
</tr>
<tr>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Negligible</td>
<td>Negligible</td>
</tr>
</tbody>
</table>

Residual Effects

11.34 A statement of residual effects, following consideration of any further specific mitigation measures where identified, is then given.

Cumulative Effects Assessment

11.35 Cumulative effects are not considered relevant to the geological environment and are not considered further in this Chapter.

Statement of Significance

11.36 The geological environment assessment concludes with a Statement of Significance associated with the proposed development. Effects of ‘major’ and ‘moderate’ significance are considered to be ‘significant’ in terms of the EIA Regulations.
BASELINE CONDITIONS

11.37 The Site location and local setting is shown on Figure 11.1.

11.38 A detailed assessment of the hydrology and hydrogeology at and near the Site, is provided in Chapter 13: Hydrology and Hydrogeology.

Geology and Peat

Soils

11.39 Based on published soil mapping, a review of the information indicates there is evidence of peat deposits on the Site. The published soil survey map (Macaulay Institute for Soil Research Sheet 7 Eastern Scotland Soil, 1982) describes two main soil types on site, primarily peaty gleys and brown soils. This indicates the soils underlying the Site belong to the Ettrick soil association and has parent material that has been derived from Lower Palaeozoic greywackes and shales. The majority of the Site is underlain by peaty gleys with a small proportion of the Site in the north and in the east underlain by brown soils comprising brown earths with non-calcareous gleys.

11.40 Three areas of peat occur on Harryburn Brae, Dun Moss adjacent to Peat Hill and Bulmer Moss. Most of the proposed access track is underlain by peaty gleys or peat, overlying shallow weathered bedrock.

Superficial Geology

11.41 Alluvial deposits of silt, sand and gravel are regionally present in the valley areas of the watercourses to the south and east of the Site, with alluvium along the Elvan Water within the Site. Occasional areas of glacial till and hummocky glacial deposits are recorded in the valley floors. An extract of the Superficial Geology map is presented in Figure 11-2.

11.42 Where present, areas of superficial deposits comprise primarily glacial till, which is indicated on lower ground close to Elvanfoot and on some of the slopes. It would appear there is no glacial till on the tops of the hills, with just localised peat and peaty gleys overlying shallow rock.

11.43 With regards to the superficial geology, geological mapping shows that beneath much of the Site there is limited or no superficial geology, with bedrock at or close to the surface. According to the superficial geology map, peat has been recorded within the Site, in a number of areas notably Harryburn Brae, Dun Moss and Peat Hill and Bulmer Moss. A few localised peaty areas occur to the south at Toddle Moss and close to the Site entrance, near Elvanfoot.

Bedrock Geology

11.44 The bedrock geology, either at surface or beneath the superficial deposits across the Site comprises Lower Palaeozoic (Ordovician) sedimentary rocks from the Leadhills Supergroup and predominantly the Portpatrick Formation.
which is part of the Scaur Group. These rocks are described in the British Geological Survey (BGS) Memoir for the area as greywackes, i.e. poorly sorted turbidite sandstones with a mud matrix, which are interbedded with siltstones and sandstones.

11.45 The Portpatrick Formation, of the Scaur Group and Leadhills Supergroup is fault bounded to the north by the Leadhills fault, a very significant fault imbrication zone responsible for much of the mineralisation evident in the Leadhills area. Immediately south of the Portpatrick Formation is the Shinnel Formation. The site infrastructure is located primarily on the Portpatrick Formation, with the extreme north of the site bound by a major fault which separates the Portpatrick from the Moffat Formation. No infrastructure is located on the Shinnel Formation to the south (Figure 11.4).

11.46 The Shinnel Formation also comprising wackes of the Scaur Group and Leadhills Supergroup, is fault bounded to the south. The faults are thrust faults and trend north east to south west.

11.47 Adjacent to the more northern thrust fault are rocks of the Moffat Shale group, which comprise black shale, grey shale and tuff deposits. These are interbedded with the Crawford Group, mudstones and cherts and the Kirkholm Formation greywacke sandstones.

11.48 An extract of the bedrock geology map Sheet 15E – Leadhills – Solid Edition is presented as Figure 11.4. The following table outlines a summarised geological description of soils, superficial geology and bedrock present at the proposed development. Table 11-5 provides a summary of the geological characteristics across the Site.
Table 11-5: Summary of Onsite Geological Characteristics
(Based on Soils and Geology Maps)

<table>
<thead>
<tr>
<th>Geological Unit</th>
<th>Characteristics of Superficial Deposits and Bedrock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial Deposits</td>
<td>Undifferentiated till and hummocky ice contact glacial deposits. The deposits contains angular to well rounded and striated pebbles and cobbles mostly of local rock types but including some far-travelled erratics in a predominantly sandy matrix. The glacial till is relatively compact and resistant to erosion in the undisturbed state. However, the high silt content will make the material very susceptible to erosion when disturbed or re-compacted.</td>
</tr>
<tr>
<td>Moffat Shale Group</td>
<td>Mudstones</td>
</tr>
<tr>
<td>Shinnel Formation</td>
<td>Greywacke sandstones with thick siltstone and conglomerate</td>
</tr>
<tr>
<td>Portpatrick Formation</td>
<td>Greywacke sandstones with conglomerates</td>
</tr>
<tr>
<td>Kirkholm Formation</td>
<td>Greywacke sandstones with some thick siltstone intercalations</td>
</tr>
<tr>
<td>Crawford Group</td>
<td>Mudstones with localised chert bands</td>
</tr>
</tbody>
</table>

11.49 The BGS GeoIndex website shows that there are no active mines or quarries within the vicinity of the Site. There is extensive evidence of historic mining and prospecting within the Site, particularly to the south west towards Leadhills and Wanlockhead, beyond the Site boundary. The mineralisation found in the area is associated with mineral veins, which are narrow and steeply dipping and primarily trend in a north northwest to south southeast orientation.

11.50 There are no historic quarries within the Site boundary and only one historic quarry near Glenochar, on the A702, just outside the Site boundary.

11.51 An assessment for borrow pits has been undertaken and has not identified any suitable locations for borrow pits on Site. The background to this decision is outlined in Chapter 3: Description of the Development.

11.52 A number of areas of historic mining activity have been identified and are outlined in detail in Technical Appendix 11.3 Mining Desk Study Report. The section of the Site which is likely to be close to historic mine workings occurs to the extreme west of the Site, where a number of shafts, adits and mineral veins are present. This area is peripheral to the main area of historical mining activity located to the south and west of the Site towards Leadhills and Wanlockhead.

Receptor Sensitivity

11.53 Table 11-6 outlines the receptors identified as part of the baseline study, and their sensitivity based upon the criteria contained in Table 11-2. These
receptors form the basis of this assessment, and as per the methodology, are used in conjunction with an estimate of the magnitude of significance of effect.

11.54 There are two Sites of Special Scientific Interest (SSSI) in the vicinity of the study area (Figure 11.2 & 11.4): Raven Gill and Leadhills / Wanlockhead (which consists of three separate areas). Raven Gill is located just outside the Site boundary and would be considered to have a High sensitivity as a geological SSSI.

11.55 Raven Gill is a geological SSSI. It displays rocks of demonstrably Arenig Age (Lower Ordovician). The Site provides evidence that constrains the dating of sedimentation during the early Lower Palaeozoic in the Southern Uplands basin. Potential effects on the SSSI are considered and detailed in Table 11-6.

11.56 Leadhills / Wanlockhead SSSI relates to mining heritage, and is over 2km from the Site and is not connected geologically so is not considered further in this Chapter.

11.57 Peat is present on the Site and three areas of peat are identified at Harryburn Brae (Photo 1), Dun Moss/Peat Hill (Photo 2) and Bulmer Moss (Photo 3) as Category 1 soils, based on SNH’s Consultation Analysis Report on peat¹. Each area is therefore defined as a high sensitivity Class1/2 peatland habitat (Figure 11.3a). However, based on site walkovers and assessment by geologists, ecologists and hydrogeologists the areas identified are all subject to a number of key issues, outlined in Technical Appendix 11.1 which reduce the status of these peat habitats from high to ‘moderate to low’.

¹ Carbon-rich soil, dep peat and priority peatland habitats, SNH, June 2016
Photo 1 Harryburn Brae eroded and drained

Photo 2 Dun Moss and Peat Hill extensively drained
11.58 The detailed assessments are included in the Chapter 9: Ecology and Chapter 13: Hydrology and Hydrogeology and the Peat Landslide Hazard and Risk Assessment (Technical Appendix 11.1), which outline why this area is not considered a High Sensitivity Receptor. The main factors contributing to the down grading is the extent of heavy grazing together with muir burn, erosion, dewatering from artificial drainage and current recreational activities (grouse shooting).

11.59 The peat which is present on the Site therefore varies from low to moderately sensitive, it is an extensively modified blanket bog, impacted by significant drainage across the Site, been subject to muir burn and grazing and in areas, extensively hagged and eroded. The Site infrastructure has therefore been designed to avoid peat where possible and Figure 11.3b illustrates the current proposed layout, taking into account presence of peat, but also engineering constraints. Where deep peat has been traversed on Peat Hill, there has been no alternative due to engineering constraints and the mitigation in this instance incorporates floating roads across the peat. The potential risk to the peat is from excavation impacting both the quality of the peat and the stability of the peat.

11.60 Both of these matters, including mitigation measures have been addressed in the Peat Landslide Hazard and Risk Assessment (TA11.1) and the Peat Management Plan (TA11.2)
Soils and superficial geology of the Site are determined as not sensitive and are not considered any further in this assessment.

Table 11-6: Sensitivity of Receptors

<table>
<thead>
<tr>
<th>Receptors</th>
<th>Sensitivity</th>
<th>Reason for Sensitivity</th>
<th>Effects Assessed for Construction and Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raven Gill SSSI</td>
<td>High</td>
<td>Receptor is of high geological importance or National or International value (e.g. Site of Special Scientific Interest (SSSI)), # Landslide and ground stability</td>
<td></td>
</tr>
<tr>
<td>Peat</td>
<td>Low to Moderate</td>
<td>Soil type and associated land use is moderately sensitive (e.g. modified blanket bog peatland).</td>
<td>Peat Landslide, degradation of peat quality</td>
</tr>
<tr>
<td>Bedrock Geology</td>
<td>Low</td>
<td>Potential for historic mining of bedrock to be impacted during construction</td>
<td>Ground Instability</td>
</tr>
<tr>
<td>Soils</td>
<td>Not Sensitive</td>
<td>Soil type not sensitive to change, in intensively grazed area</td>
<td>Degradation of soil quality</td>
</tr>
<tr>
<td>Superfical geology</td>
<td>Not Sensitive</td>
<td>Superficial geology not sensitive to change, limited to mainly slopes and avoids most of the infrastructure slopes area</td>
<td>Degradation of superficial deposits</td>
</tr>
</tbody>
</table>

ASSESSMENT OF EFFECTS

The assessment of effects is based on information presented in Chapter 3: Description of the Development and is structured as follows:

- construction effects of the proposed development; and
- operational effects of the proposed development.

The Proposed Development Layout Considerations

The proposed development has undergone design iterations and evolution in response to the constraints identified as part of the baseline studies and field studies so as to avoid and/or minimise potential effects on receptors where possible. This has included geological constraints which include presence of Raven Gill SSSI, extent of peat and extent of historic mine workings.

The soils and superficial geology are not considered significant and are not assessed any further.
Raven Gill SSSI

11.65 The Site layout avoided the Raven Gill SSSI, with closest infrastructure and track located more than 250 metres south from the locality, no construction activity is proposed within 250m of the Geological SSSI.

11.66 The SSSI is considered a High sensitivity receptor, however the magnitude of impact is considered Negligible as there would be no impact or alteration to the existing geological environs. The significance of the effects must therefore be considered Negligible.

Peat

11.67 The extent of peat on the Site was assessed in accordance with the guidelines on Peat Landslide and Hazard Risk Assessment (PLHRA) by the Scottish Executive (SE) (now Scottish Government) for the investigation, assessment, and reporting for wind farms in peat areas. The analysis and interpretation is based upon the results obtained from this process as well as previous experience and the results of case studies elsewhere. The assessment of the peat on Site is detailed in Technical Appendix 11.1.

11.68 Modifications to track layout has been undertaken through the iterative layout design process, to avoid areas of concern, identified as part of the PLHRA. As a consequence most of the tracks would be located around Harryburn Brae and Coom Dod as cut and fill onto glacial till or weathered shallow rock, thereby mitigating risk. Only one small section of track would be floating track (where rerouting was impossible) to minimise excavation of deep peat. In the majority of the Site deep peat has been avoided.

11.69 The resultant stability risk plan for the Site included in TA11.1, confirms that all of the proposed turbines and enabling infrastructure are shown to lie in areas of low or negligible stability risk.

11.70 The peat is considered a Low to Moderate sensitivity receptor, however the magnitude of impact must be considered Low as there would be minor impact or alteration to the existing geological environs with mitigation measures specified in TA 11.1 and TA 11.2. The significance of the effects must therefore be considered Minor.

Historic Mining Activity

11.71 The section of the Site which would be close to historic mine workings occurs to the western of the Site, the turbine locations and crane hard standing areas are located away from any historic mining features (Figure 11.5).

11.72 The design of the track has been progressed to use as much of the existing estate tracks as is possible. A section of track between T9 (NGR 291861,619616) and beyond T12 (NGR 291417,618135) has been located on the existing estate track and would be upgraded to meet the appropriate wind farm specification.
11.73 To meet engineering requirements the track design has been unable to avoid being located within close proximity of some of the historic mining features and the design would require further detailed assessment (probably site investigation) to determine ground stability, along small sections of the track.

11.74 Mitigation measures to reduce the effect from past mining activities have been incorporated into the detailed track design, this would include the re-use of existing tracks to minimise disturbance to mining wastes and avoidance of past mining infrastructure.

11.75 The main area of concern with regards to historic mining, is the track between T11 and T9 and T12 and T15 around the area of Whitfields Shaft and Ramages Shaft which may require a further mining assessment and site investigation to confirm detailed design of the track. In both of these areas the track has been located to utilise and upgrade the existing track. By upgrading existing track, disturbance to historic mine workings would be minimised, thereby reducing disturbance of mining derived waste. However subject to detailed site investigation, the design may be subject to micrositing to avoid historic mining locations including adits or shafts.

11.76 The bedrock geology is considered a Low sensitivity receptor, however the magnitude of impact is considered Low as there would be minor impact or alteration to the existing geological environs. The significance of the effects is considered to be Minor.

**Good Practice Measures**

11.77 Good Practice Measures would be adhered to during the construction and operation of the proposed development. Good practice measures would be applied in relation to pollution risk, and management of surface runoff rates and volumes. This would form part of the draft CEMP (Technical Appendix 3.1) to be implemented for the proposed development.

11.78 innogy is committed to implementing good practice measures as a matter of course during the construction of the proposed development and these are not considered to be mitigation measures, but form an integral part of the design/construction process.

11.79 Key good practice measures in relation to geology and peat are stated below and the assessment incorporates these measures as part of the proposed development. Any further specific mitigation which may be required to reduce the significance of a potential effect is identified in the assessment of likely effects during the construction and operation phases.

**General Measures**

11.80 The design utilises where practical the existing tracks in the western portion of the Site to minimise the risk of disturbing historic mining wastes and materials.
11.81 The developer would prevent the release of any pollution/sediment during the construction and operation phase. Details of how this would be done are contained in the Draft CEMP and Chapter 13, Hydrology and Hydrogeology.

Construction Effects of the Proposed Development

11.82 Construction activities, as set out in Chapter 3: Description of the Development, have the potential to affect geological receptors, in particular excavation of peat. Mitigation during construction is detailed in TA11.1 the Peat Landslide Hazard and Risk Assessment.

11.83 There is no risk from construction to the SSSI identified. The SSSI is located over 250m downgradient of the Site and there is no direct pathway from the proposed development which could impact the geological value of the SSSI.

11.84 This assessment assumes that good practice would be applied throughout construction and the levels of predicted magnitude are based on this assumption.

Predicted Effects

11.85 During the construction phase, there is a negligible to minor impact predicted to affect the geology of the Site.

Proposed Mitigation

11.86 As there are no predicted significant effects, under the terms of the EIA Regulations, other than the good practice measures that innogy would implement as standard (and as described in this Chapter), no specific mitigation during construction is required for the SSSI. Mitigation relating to the treatment and re-use of the peat is summarised in the PLHRA TA 11.1.

Residual Effects

11.87 No significant residual effects on geological receptors are predicted during the construction period of the proposed development.

Operational Effects of Proposed Development

11.88 During the operational phase of the proposed development, it is anticipated that routine maintenance of infrastructure and tracks would be required across the Site. This would include work such as maintaining wind farm tracks and drainage and turbine maintenance.

Predicted Effects

11.89 During the operational phase, there is a negligible to minor impact predicted to affect the geology of the Site.
**Proposed Mitigation**

11.90 As there are no predicted significant effects under the terms of the EIA Regulations, other than the good practice measures that innogy implement as standard no specific mitigation during operation, is required.

**Residual Effects**

11.91 No significant residual effects on geological receptors are predicted during the operational period of the proposed development.

**Summary of Effects**

11.92 A summary of effects and proposed mitigation measures required to reduce the potential effects to acceptable levels are identified in Table 11-7.

**Table 11-7: Summary of Residual Effect after Mitigation**

<table>
<thead>
<tr>
<th>Potential Effect</th>
<th>Significance of Effect before Mitigation</th>
<th>Proposed Mitigation / Enhancements</th>
<th>Significance of Residual Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peat landslide and deterioration of peat</td>
<td>Low to Moderate</td>
<td>None required above good practice techniques identified in the PLHRA</td>
<td>Minor</td>
</tr>
</tbody>
</table>

**Statement of Significance**

11.93 This Chapter has assessed the likely significance of effects of the proposed development on the surrounding geology.

11.94 The proposed development has been assessed as having no significant effects following the adoption of good practice measures and specific mitigation measures. There are also no potential cumulative effects with any other developments.

**References**


British Geological Survey Scotland – Geology of the Leadhills District, Sheet Memoir.


BGS Map and Map data viewers (www.bgs.ac.uk/data/mapViewers/home.html)

Scotland’s Environment (www.environment.scotland.gov.uk)

Environmental Good Practice on Site C650, CIRIA, 2005;

Carbon Rich Soil, deep peat and priority peatland habitat, Scottish Natural Heritage, April 2016 (http://www.snh.gov.uk/docs/A2010617.pdf)

Correspondence with utility companies to confirm the location of their assets near to Site.