TA 2.3: Peat Depth Survey Results

Technical Appendix 2.3: Peat Depth Survey Results

1.1 Introduction

1.1.1 Ramboll was commissioned by the Applicant to undertake peat depth and coring surveys to aid the design process and to inform an assessment of the nature and condition of the peatland for the Proposed Development.

1.1.2 This Technical Appendix has been produced in accordance with guidance published by the Scottish Environment Protection Agency (SEPA), NatureScot, and the Scottish Government, which is referenced in the following sections.

1.1.3 This Technical Appendix is supported by the following:

- Figure 2.3.1: Peat Depth;
- Figure 2.3.2: Solid Geology;
- Figure 2.3.3: Extract of NatureScot/ SNH Carbon and Peatland 2016 Map;
- Annex 2.3.1: Peat Coring Data; and
- Annex 2.3.2: Core Sample Photographs.

1.2 The Site and Study Area

1.2.1 The Proposed Development Site ('the Site') covers an area of approximately 1,074 hectares (ha) and is located approximately 8 km south east of Dufftown, Moray. The Site is centred at approximate Ordnance Survey National Grid Reference NJ 37509 34022 (as shown in Figure 1.1: Site Location). The Site topography is generally undulating at elevations of between 320 m to 501 m Above Ordnance Datum (AOD).

1.2.2 Much of the Site is dominated by semi-mature coniferous plantation woodland, with some underlying marshy grassland and wet heath. Open areas of blanket bog and dry modified bog are located in the south western portion of the Site and around the slopes of Craig Watch. A mosaic of wet and dry heath, acid, improved and marshy grassland is located along the south western and south eastern corners of the Site. The A941 runs along the Site's south western boundary. There is also a minor road stretching along and across the Site's eastern and south eastern boundary, in the River Deveron valley.

1.2.3 The Site location and setting are described in more detail within Chapter 2: Development Description. The peat area focussed on the developable area of the Site (Figure 2.3.1 of this Technical Appendix).

1.2.4 The 1:50,000 and 1:625,000 scale geological mapping available from the British Geological Survey (BGS)[1] shows the majority of the northern, central, and western parts of the Site underlain by bedrock mapped as the Appin Group, comprising metamorphic graphitic pelite, calcareous pelite, calsilicate rocks and psammite. This is interspersed with metamorphic rocks belonging to the Appin Group and the Argyll Group, both comprising metamorphic quartzite. To the east, the Site is underlain by the Argyll Group, comprising metamorphic psammite, semipelite and pelite, and unnamed igneous rocks comprising neoproterozoic mafic lava and mafic tuff. A small igneous intrusion is also present in this area. The 1:625,000 BGS mapping is shown on Figure 2.3.2 of this Technical Appendix.

1.2.5 The superficial geology of the Site comprise areas of peat, particularly in the northern and central areas, with Devensian aged Till (diamicton) or Devensian aged Till, alluvium and river terrace deposits (undifferentiated) present in most other areas.

1.2.6 Peat deposits are shown to be predominantly present in the area south of Craig Watch Hill, and to the west of Brown Hill on the western boundary of the Site. Additional localised areas of peat are shown to be present on the eastern slopes of Meikle Balloch Hill.

1.2.7 The carbon rich soils, deep peat and priority peatland habitat mapping[2] shows that areas of peat and organic material are present across parts of the Site. Most of the peat is shown as Class 4 or Class 5, with a small area of Class 3 however, there are some areas of Class 1 peat indicated to be located in the northern and central areas of the Site ('nationally important carbon rich soils, deep peat and priority peatland habitat'). Some smaller areas of Class 2 are also indicated to be present in the central part of the Site ('nationally important carbon rich soils, deep peat and priority peatland habitat'). These are shown in Figure 2.3.3 of this Technical Appendix.

1.3 Methodology

1.3.1 Peat surveys were undertaken at the Site to understand the baseline peat conditions and potential constraints, and to inform the design of wind farm infrastructure to minimise, as far as practicable, the potential direct and indirect effects on peat and carbon rich soils.

The surveys were undertaken by Ramboll on the following dates:

- Stage 1 peat probing – between 2 January 2021 and 9 January 2021 (survey abandoned due to poor weather) and 16 March 2021 and 23 March 2021; and
- Stage 2 peat probing and coring – between 7 July 2021 and 15 July 2021.

1.3.2 Surveys followed best practice guidance published at the time of the surveys with regard to surveying for developments on peatland[3,4]. The methods employed for peat depth probing and peat coring are detailed further below.

Phase 1 Peat Probing

1.3.3 The Phase 1 is a preliminary, low density survey and was carried out on a 100 m grid across the developable area of the Site, with additional points taken at the then considered turbine bases. The probing was carried out using collapsible avalanche probes, allowing for probing in excess of 6 m. However, such depths were not reached. This peat depth data along with other environmental and engineering constraints were used to inform the layout of the Proposed Development, including the turbine locations, substation, access tracks, met mast, borrow pits and compounds.

1.3.4 The survey points and field data were collected using a handheld Trimble GPS unit. Peat depth data was modelled using Inversive Distance Weighted (IDW) interpolation in GIS software, and a depth model generated using incremented peat depth categories.

[1] British Geological Survey Online Viewer (https://mapapps.bgs.ac.uk/geologyofbritain/home.html).

[2] Scottish Natural Heritage. (2016). *Carbon and Peatland 2016 Map (http://map.environment.gov.scot/soil_maps/).*

[3] Scottish Government, Scottish Natural Heritage, SEPA. (2017). *Peatland Survey. Guidance on Developments on Peatland, online version only.*

[4] Scottish Renewables and SEPA (2012). Development on Peatlands. Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste.

Phase 2 Peat Probing and Coring

1.3.5 The high-density probing during the Phase 2 survey was carried out along the access tracks, and in the planned turbine, crane pad, and compound locations, known at the time of the survey. This included a 50 m micrositing zone around each turbine location. The sampling pattern comprised:

- Proposed turbine locations: peat probing was undertaken at 10 m intervals along cardinal points from the central point of the infrastructure; and
- Proposed new tracks: the alignment was probed at 50 m intervals along the track and at points every 10 m perpendicular to the centreline on either side of the proposed track.

1.3.6 Again, this was carried out using collapsible avalanche probes, allowing for probing in excess of 6 m, and data collected using a handheld Trimble GPS unit.

1.3.7 Should turbines be microsited within a distance greater than 50 m, then further targeted peat probing would be undertaken post application.

1.3.8 Peat cores were taken using a Russian auger, with a sample volume of 0.5 l, and a number of field tests and observations were undertaken. The probing results are included in Annex 2.3.1 of this Technical Appendix, and records taken include:

- Depth of acrotelm;
- Degree of humification (using Hodgson, 1974), to establish amorphous, intermediate, fibrous and content;
- Degree of humification using the Von Post classification;
- Fine fibre content, based on scale of F0 (none) to F3 (very high);
- Coarse fibre content, based on scale of R0 (none) to R3 (very high);
- Water content, based on scale of B1 (dry) to B5 (very wet); and
- Substrate underlying the peat where this was possible.

1.3.9 A peat depth probe was taken adjacent to the core location, and cores were photographed (refer to Annex 2.3.2 of this Technical Appendix).

1.3.10 Samples of known volume were taken for laboratory analysis. During laboratory analysis, the samples were weighed, dried, and a subsample taken for loss on ignition testing. The total moisture content was determined from weight measurements. Peat pH was also determined.

1.4 Limitations

1.4.1 The design of the Proposed Development has considered the proximity of peat, along with other technical and environmental constraints, and infrastructure has been sited away from these areas, where possible.

1.4.2 Peat probing and mapping has been used to inform the design process, at strategic points in the design evolution of the Proposed Development. However, there are some differences between the final design and the extent of the peat survey results based on design changes made through this process, as a result of micrositing etc.

1.4.3 However, the peat survey probing points do provide high resolution coverage of the Site, and these revealed the peatland to be typically shallow (less than 1.0 m) but with several pockets of deeper peat. It is considered that the peat depths collected, and interpolations derived from these data, are representative of the Site and have adequately informed the layout of the Proposed Development.

1.4.4 Survey coverage was limited in some areas of dense vegetation where there was poor satellite/ GPS signal, and areas that could potentially affect the safety of the surveyors (such as areas of brash, felled areas etc).

1.4.5 The Stage 1 survey was undertaken in two phases as poor weather resulted in the survey being abandoned. The rescheduled Stage 1 survey completed the survey with no deviations in coverage.

1.5 Results

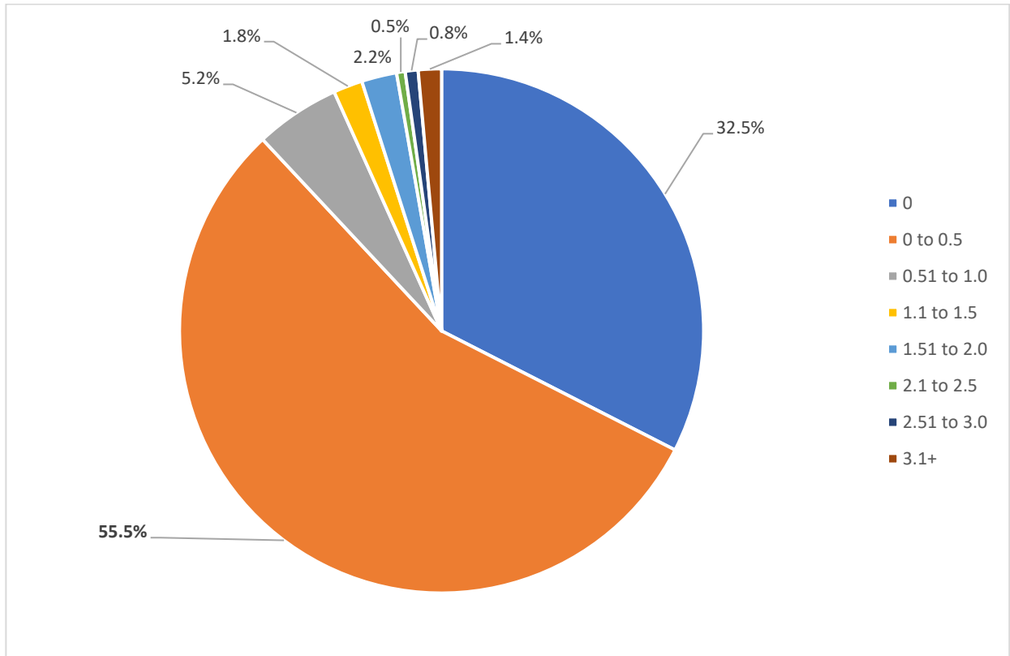
Peat Probing

1.5.1 During the peat depth probing surveys, a total of 843 peat depth probes were taken during the Phase 1 peat survey and 1,046 peat depth probes during Phase 2. Therefore, there is a combined peat depth dataset of 1,889 probes, as shown in Figure 2.3.1 (of this Technical Appendix).

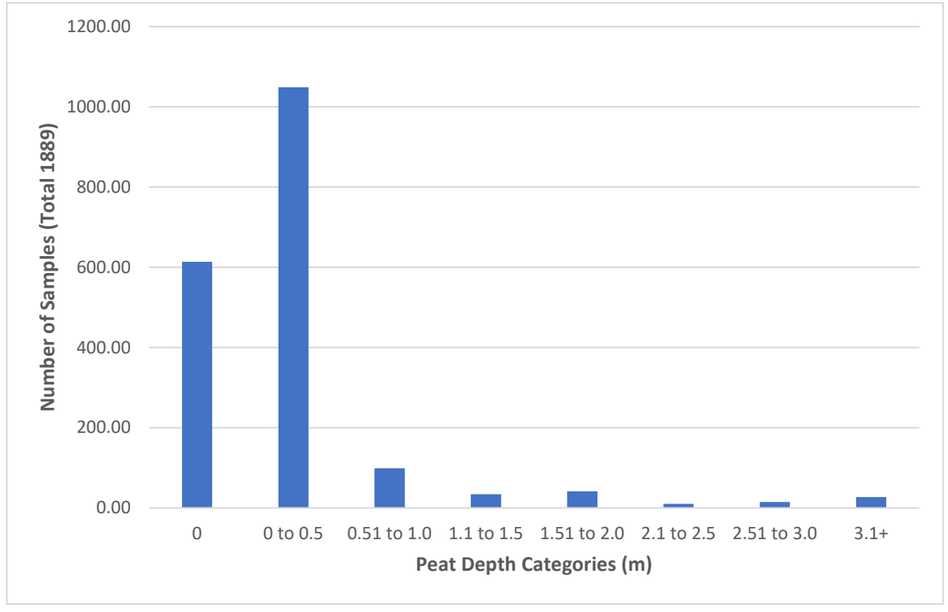
1.5.2 Figure 2.3.1 (of this Technical Appendix) shows the results of the peat depth survey at the Site, as well as the specific depth class at each sample location. Figure 2.3.1 (of this Technical Appendix) is based on IDW data interpolation and consequently the peat depth contours and boundaries are to a degree indicative.

1.5.3 Graph 2.3.1 and Graph 2.3.2 below present the percentage and frequency of peat probe results within the specific peat depth categories recorded during the Phase 1 and Phase 2 surveys.

Graph 2.3.1: Percentage Peat Depth Categories (All Surveys Combined)



Graph 2.3.2: Peat Depth Frequency Distribution



1.5.4 As shown on Graph 2.3.1 and Graph 2.3.2, most of the developable area of the Site has either no peat present or has a shallow depth of peat present (approximately 88% were <0.5 m in depth). These areas of shallow peat can be considered as organo-mineral soils, and therefore not considered as deep peat. These are further summarised as follows:

- 614 no. samples (32.5%) located on land with no peat/ absent;
- 1,049 no. samples (55.5%) located on land with less than or equal to 0.5 m depth of peat or organo-mineral soil;
- 99 no. samples (5.2%) fell on land with between 0.51 m and 1.0 m depth of peat; and
- 127 no. samples (6.7%) located on land with more than 1.0 m of peat.

1.5.5 The maximum depth of peat recorded at the Site was 5.2 m, located in the central part of the Site during the Stage 1 survey. The maximum depth of peat recorded during the Stage 2 peat probe survey was 3.0 m, also located to the central part of the Site, north of Turbine 8. The mean peat depth recorded was 0.31 m.

1.5.6 Land where peat depth is greater than 0.5 m is classified as 'blanket bog' by NatureScot (MacDonald *et al*., 1998)[5] and JNCC (JNCC, 2010)[6]; however, some areas with a peat depth of less than 0.5 m can still form part of the wider hydrologically connected mire, or macrotope. As per above, much of the peatland or organo-mineral soil habitats within the Site have less than 0.5 m of peat/ soil present.

Accuracy of Peat Depth Probes

1.5.7 At each core sample location, a peat depth probe was taken adjacent to the core sample to compare the probed depth against the true depth determined by measuring the depth of material retained in the core sample.

1.5.8 To ensure the full depth of peat is sampled, a core is extracted that confirms the peat/ substratum boundary has been reached. This approach allows a relative assessment of the accuracy of the peat depth probing. Peat or organo-mineral soil was present at all sample locations. The results are presented in Annex 2.3.1.

1.5.9 Peat probes tend to overestimate the true peat depths when compared to coring (in this case there is a mean overestimation of 0.69 m). This is generally as a result of the density of peat and the difference in design of the peat probe and Russian auger, whereby the probe is narrower and is easier to penetrate deeper into the peat layers.

Core Sample Results

Accuracy of Peat Depth Probes

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1.5.11 To ensure the full depth of peat is sampled, a core is extracted that confirms the peat/ substratum boundary has been reached. This approach allows a relative assessment of the accuracy of the peat depth probing. Peat or organo-mineral soil was present at all sample locations. The results are presented in Annex 2.3.1.

1.5.12 As previously mentioned, peat probes tend to overestimate the true peat depths when compared to coring (in this case there is a mean overestimation of 0.69 m). This is generally as a result of the density of peat and the difference in design of the peat probe and Russian auger, whereby the probe is narrower and is easier to penetrate deeper into the peat layers.

Depth of Acrotelm

1.5.13 The acrotelm and catotelm represent two distinct layers within undisturbed peat that control the hydrological regime. The catotelm is the bottom layer of peat that is mostly below the water table. The acrotelm overlies the catotelm and is the 'living' layer in which most water table fluctuations occur. The thickness of the acrotelm usually varies up to around 0.5 m, but it largely depends upon the habitat. Anaerobic and aerobic conditions alternate periodically with the fluctuation of the water table, favouring more rapid microbial activity than in the catotelm. The acrotelm consists of the living parts of mosses and dead and poorly decomposed plant material. It has a very loose structure that can contain and release large quantities of water in a manner that limits variations of the water table in peat bogs.

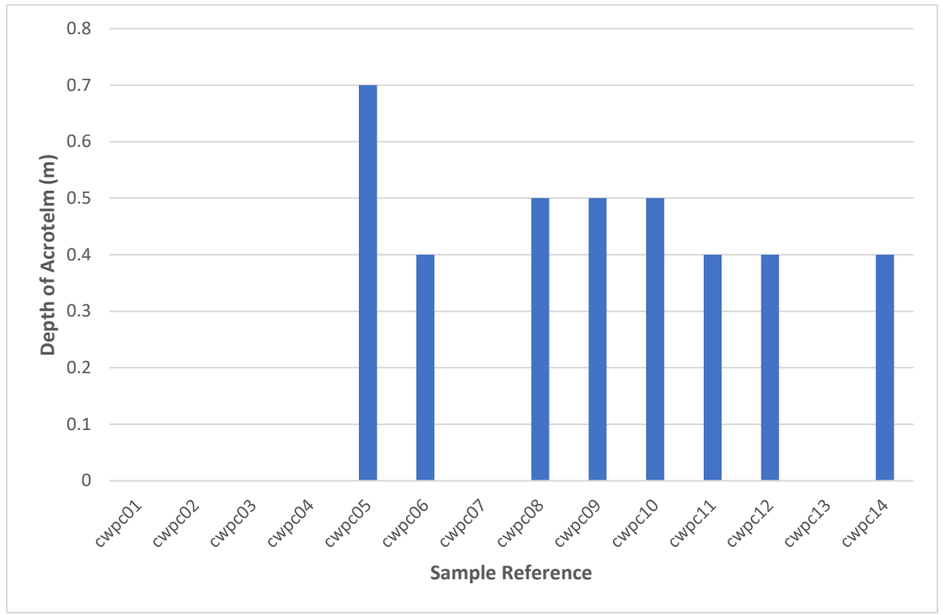
1.5.14 Graph 2.3.3 shows that acrotelm was recorded at (8) eight sample locations, with a mean depth of 0.27 m. The other sample locations indicated no discernible acrotelm.

1.5.15 In the context of any development, it is recommended that for the purposes of construction and subsequent reinstatement, that where a sufficient peat depth exists, the top 0.5 m of material should be treated as acrotelm. This approach will allow excavation of intact turves for reinstatement purposes where they are present, which will in turn facilitates quicker regeneration of disturbed areas. Even if little vegetation is present within this top layer it should still be treated as acrotelmic material as it may contain a seedbank, particularly in open habitats, which will aid re-vegetation of reinstatement areas.

[5] MacDonald, A. Stevens, P., Armstrong, H., Immirzi, P. and Reynolds, P. (1998). A Guide to Upland Habitats: Surveying Land Management Impacts (Volume 1). NatureScot/Scottish Natural Heritage, Edinburgh.

[6] JNCC (2010) Handbook for Phase 1 Habitat Survey, Joint Nature Conservation Committee, Peterborough.

Graph 2.3.3: Depth of Acrotelm

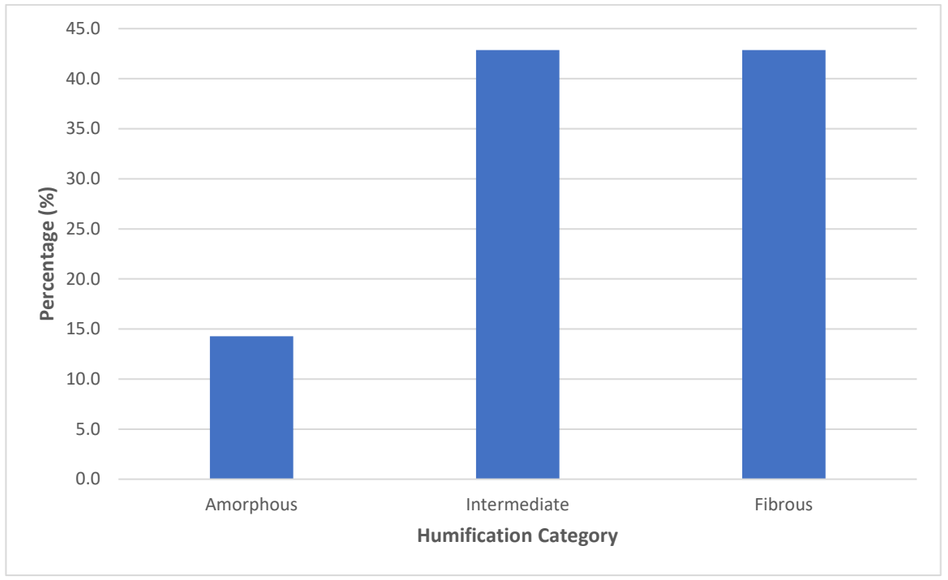


Degree of Humification

1.5.16 The degree of humification was recorded in the field, in accordance with the methods discussed in the methodology section, with each 0.5 m sub-sample being categorised as either fibrous, intermediate, or amorphous peat.

1.5.17 Graph 2.3.4 summarises the degree of humification, which indicates that most of the samples are classed as either intermediate or fibrous. This is suggestive that there is a degree of humification present with some areas being subject to increased humification, with more decomposed peat present.

Graph 2.3.4: Degree of Humification



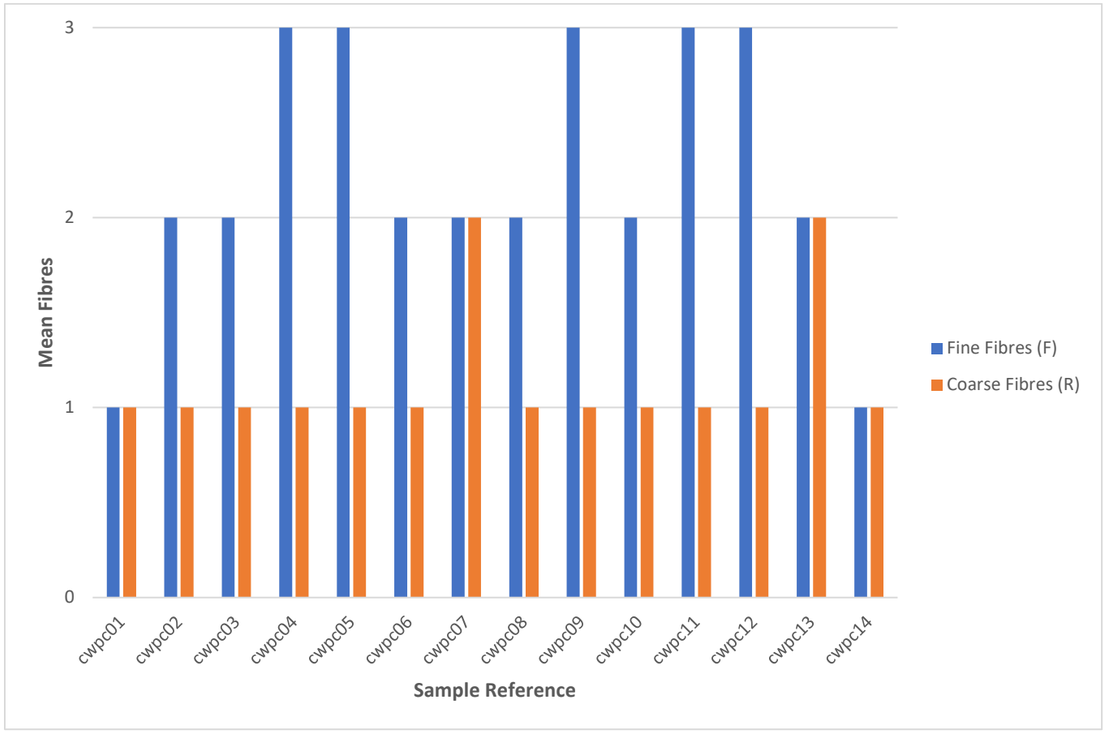
Fibrous Content

1.5.18 The proportions of coarse and fine fibres within the peat samples were derived in the field according to the Hobbs scale[7], where F0/R0 indicate no fine/ coarse fibre content to F3/R3 which are indicative of high fine/ coarse fibre respectively. This indicates that the majority of the samples were assessed as having moderate fine fibre content (F2). Five samples were assessed as having a high fine fibre content (F3) and two having a low fine fibre content (F1).

1.5.19 The majority of the sample locations were assessed as having a low coarse fibre content (R1), with two locations having a moderate coarse fibre content (R2). No samples were assessed as having a high coarse fibre content (R3). These results are summarised in Graph 2.3.5.

[7] Hobbs, N.B. (1986).Mire morphology and the properties and behaviour of some British and foreign peats. QJEG, London

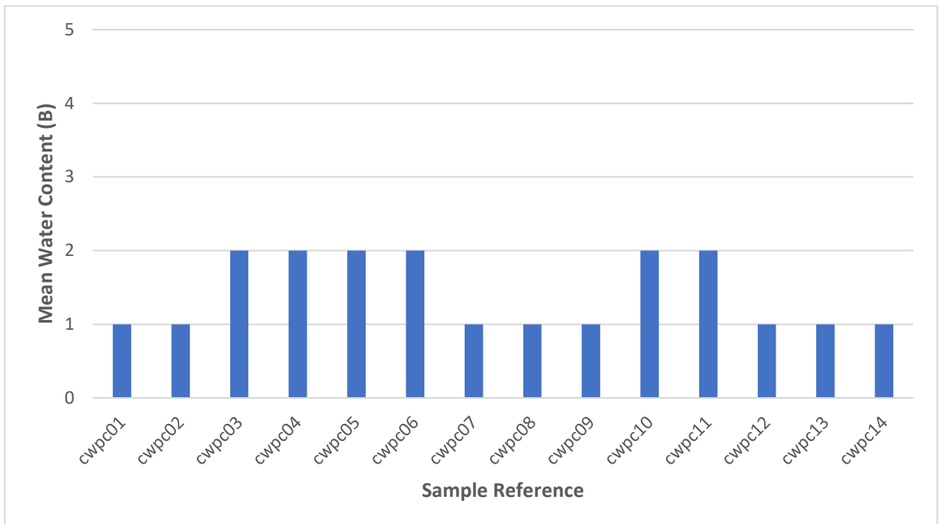
Graph 2.3.5: Fibrous Content



Water Content

1.5.20 The water content of the samples was determined in the field using the Hobbs scale, where B1 is dry and B5 is very wet. The results are summarised in Graph 2.3.6.

Graph 2.3.6: Water Content



1.5.21 The results indicate that most of the of the samples recorded are indicative of dry peat (B1) or semi-dry peat (B2). No samples were recorded as wet or very wet (B3 to B5).

Von Post (Degree of Humification)

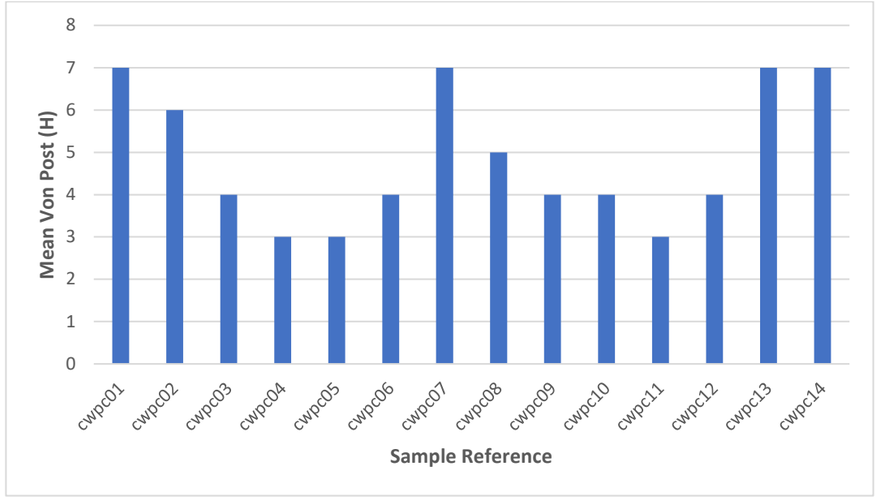
1.5.22 An estimate of the degree of humification according to the Von Post scale was carried out on samples at all core locations. The criteria associated with the Von Post scale is included in Table 2.3.1.

Table 2.3.1: Von Post Scale of Humification

Von Post Scale	Humification Description (Decomposition, Plant Material Present, Water Content, Character)
H1	Completely undecomposed peat free of amorphous material. On squeezing, clear colourless water is pressed out.
H2	Nearly undecomposed peat, free of amorphous material, yielding only yellowish brown water on pressing.
H3	Very slightly decomposed peat, containing a little amorphous material. On squeezing, muddy brown water but no peat passes between the fingers. Residue is not pasty.
H4	Slightly decomposed peat containing some amorphous material. Strongly muddy brown water but no peat passes between the fingers. Residue is somewhat pasty.
H5	Moderately decomposed peat containing a fair amount of amorphous material. Plant structure recognisable though somewhat vague. On squeezing, some peat but mainly muddy water issues. Residue is strongly pasty.
H6	Moderately decomposed peat with a fair amount of amorphous material and indistinct plant structure. On pressing, about one third of the peat passes between the fingers. Residue is strongly pasty, but shows the plant structure more distinctly than in unsqueezed peat.
H7	Strongly decomposed peat with much amorphous material and faintly recognisable plant structure. On squeezing, about one half of the peat is extruded. The water is very dark in colour.
H8	Strongly decomposed peat with much amorphous material and very indistinct plant structure. On squeezing, two thirds of the peat and some water passes between the fingers. Residue consists of plant tissues capable of resisting decomposition (roots, fibres, wood, etc.).
H9	Practically fully decomposed peat with almost no recognisable plant structure. Nearly all the peat squeezed between the fingers as a uniform paste.
H10	Completely decomposed peat with no discernible plant structure. On squeezing, all the peat, without water, passes between the fingers.

1.5.23 The results are shown in Graph 2.3.7 below, where the vertical axis refers to the Von Post scale of peat decomposition (on a scale of H1 to H10).

Graph 2.3.7: Mean Von Post

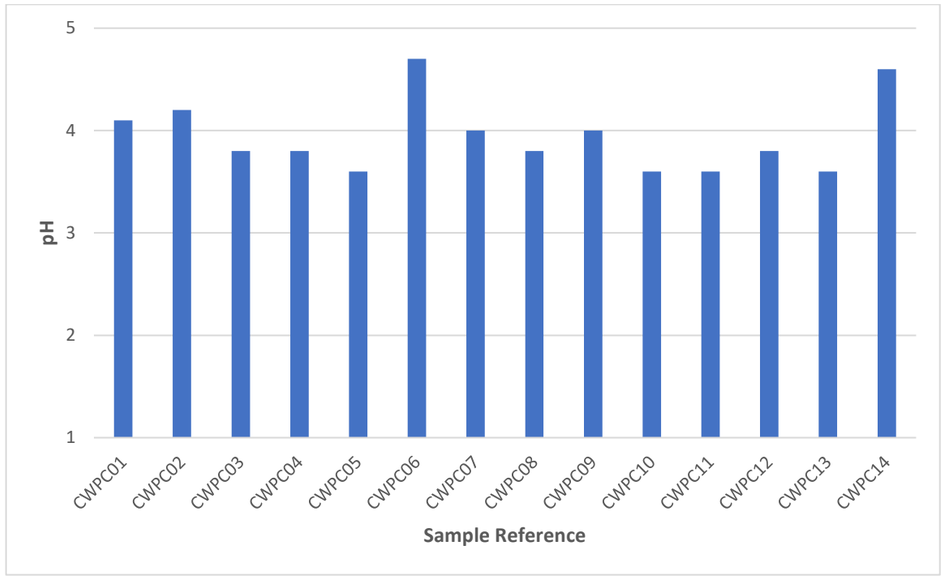


1.5.24 The results indicate that most of the samples were found to be scored relatively high on the Von Post scale (>H3) indicating a stronger rate of decomposition (between H4 and H7).

pH of Samples

1.5.25 The pH values of the core samples were analysed in a laboratory, and the results provided in Graph 2.3.8 below.

Graph 2.3.8: Mean pH

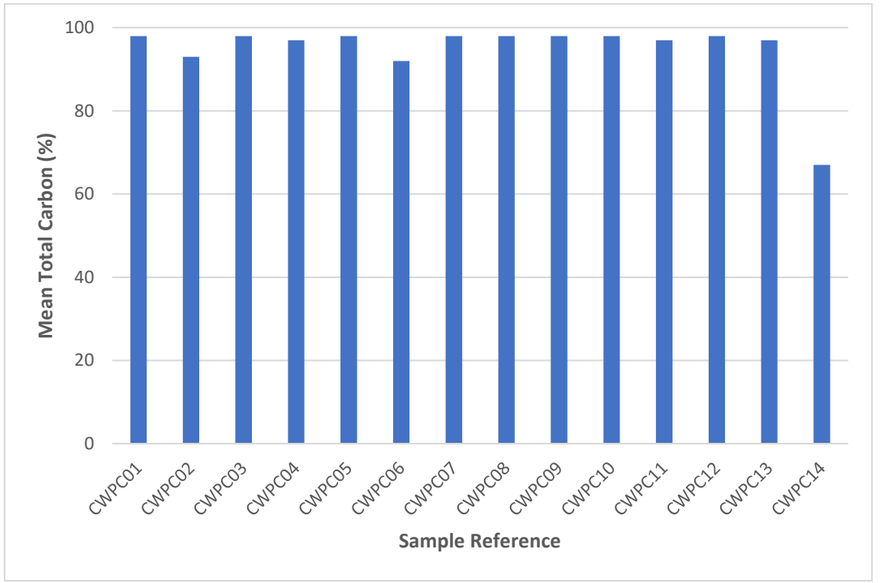


1.5.26 The mean pH value was 3.9, with a range between 3.6 and 4.7, which indicates that all samples are acidic in nature. This result is typical of peat and carbon rich soils.

Total Carbon (%)

1.5.27 The total carbon context was derived by laboratory analysis for each sample and is summarised in Graph 2.3.9. This indicates a consistent high carbon content with a mean of 94.8%. One sample recorded a significantly lower carbon content.

Graph 2.3.9: Total Carbon Percentage (%)



Underlying Substrates

1.5.28 At each location, where possible, a broad characterisation was made of the underlying substrate below the peat horizon. The underlying substrate at the majority of peat probe locations was found to be rock (1,830 locations), with the remaining areas either being cohesive or granular in nature (59 in total).

1.6 Summary

1.6.1 The results of the Phase 1 and Phase 2 surveys undertaken for the Proposed Development are as follows:

- Overall, the peat depth within the developable area of the Site is either absent of peat or is relatively shallow (88% of samples). The mean peat depth recorded across the Site is 0.31 m. The deepest areas of peat, up to 5.2 m, were noted to be in the central area of the Site, located along the western boundary to the south of Craig Watch and west of Brown Hill. Other smaller pockets of deeper peat were noted along the western and northern boundaries, and some isolated pockets within the Site itself. These are shown on Figure 2.3.1 (of this Technical Appendix). The Proposed Development has been located away from these deeper peat locations where practicable, taking into account other environmental and technical constraints, or microsited to minimise potential adverse effects. No turbines are located on deep peat.
- The depth of the acrotelm from the sample locations is 0.27 m, although it has been assumed for the purpose of assessment that the depth of acrotelm is 0.50 m.
- The peat across the Site is generally intermediate or fibrous in nature, with the majority of the samples assessed as having moderate fine fibre content (F2), with five samples having a high fine fibre content (F3). The majority of the sample locations were assessed as having a low coarse fibre content (R1), with two locations having a moderate coarse fibre content (R2). No samples were assessed as having a high coarse fibre content (R3).
- The results of the Von Post indicate that the majority of the samples tested scored between H4 and H7, indicating weakly to strong rates of decomposition.
- The mean water content of the peat at all sample locations was dry or semi-dry, which is consistent with the high degree of modification to the peatland integrity and composition through artificial drainage and overplanting with coniferous plantation forest. The drainage of the Site for the

purposes of plantation forestry has caused drying, oxidation, and erosion of peat and carbon-rich soils, which have likely increased carbon release.

- The peat was found to be acidic with a mean pH value of 3.9, and a range between 3.6 and 4.7, indicative of peat and carbon rich soils.
- Laboratory analysis of samples indicates that the peat has a high total carbon content.