Technical Appendix 10.1: Groundwater Dependent Terrestrial Ecosystems Assessment

1.1 Introduction

1.1.1 This Technical Appendix provides a summary of Groundwater Dependent Terrestrial Ecosystems (GWDTEs) within the context of the proposed Achany Extension Wind Farm (the 'Proposed Development'). It forms a Technical Appendix (TA), as part of the submission of an EIA Report for the Proposed Development. This TA provides a description of geological and hydrogeological conditions underlying the site. Characterisation of the Proposed Development area takes into account National Vegetation Classification (NVC) surveying, carried out by Alba Ecology Ltd in September 2020 and hydrological surveying carried out by Ramboll in November 2020. Hydrogeological assessment of the identified potential GWDTE's is provided with associated mapping.

1.1.2 This TA is supported by the following:

- Figure 10.1.1: Bedrock Geology;
- Figure 10.1.2: Superficial Geology;
- Figure 10.1.3: Carbon and Peatland Map (2016);
- Figure 10.1.4: Hydrogeology;
- Figure 10.1.5: NVC GWDTE Classifications;
- Figure 10.1.6: High potential GWDTE; and
- Figure 10.1.7: Ramboll GWDTE Assessment.

1.2 Baseline

Bedrock Geology

1.2.1 The British Geological Survey (BGS) 1:625,000 Geological Map of Great Britain[1] shows the underlying bedrock geology of the site is psammite of the Morar Group (Figure 10.1.1). A small area of Lewisian Gneiss is present in the south-east of the site (Figure 10.1.1c).

Superficial Geology

1.2.2 The BGS 1:625,000 Geological Map of Great Britain shows the site is overlain by superficial peat and till deposits (Figure 10.1.2). South of Beinn Sgeireach at the northern extent of the site the superficial geology is characterised by till, with another small till deposit in the north-east of the site near Loch an Ràsail (Figure 10.1.2a). The ridge between these areas at Càrn nam Bò Maola is overlain by superficial peat deposits. The BGS mapping does not record superficial geology to the north-west and southeast of Càrn nam Bò Maola indicating that it is directly underlain by bedrock geology of the Morar Group, or that superficial deposits too shallow to be mapped are present. To the southeast of the Allt an Ràsail the dominant superficial geology is peat (Figure 2b) before till deposits are again found southeast of Cnoc a' Choire (Figure 10.1.2c).

[1] Available at British Geological Society: http://mapapps.bgs.ac.uk/geologyofbritain/home.html

1.2.3 Peat soils are recorded on the National Soil Map of Scotland Carbon and Peatland Map (2016)[2] across the site (Figure 10.1.3). The majority of the site is underlain by peat soils classified as being Class 2 Peatland Soil (peaty, gleyed podzols with dystrophic semi-confined peat). However, the valley between Càrn nam Bò Maola and Beinn Sgeireach in the north of the site contains Class 1 Peatland Soil (Dystrophic blanket peat, Figure 10.1.3a), and another large area of Class 1 peatland is located towards the centre of the site due west of Loch na Fuaralaich (Figure 10.1.3b). A Peatland Condition Assessment (PCA) was undertaken by Alba Ecology Ltd (see Volume 4: Technical Appendix 8.2A) and indicates the majority of the site is modified peatland.

Hydrogeology

1.2.4 According to the BGS 1:625,000 scale hydrogeological map[3], the site is within a low productivity aquifer (Figure 10.1.4). Flow in this aquifer is virtually all through fractures and other discontinuities, with small amounts of groundwater in the near surface weathered zone and secondary fractures.

1.3 Groundwater Dependent Terrestrial Ecosystems

Introduction

1.3.1 Excavation of soil and bedrock during the construction phase of the Proposed Development may cause localised disruption and interruption to groundwater flow. Interruption of groundwater flow could potentially reduce the supply of groundwater water to GWDTEs, if present, thereby causing an alteration/ change in the quality or quantity of and/ or the physical or biological characteristics of the GWDTE. Contamination of groundwater could also cause physical or chemical contamination to the GWDTE.

1.3.2 Following identification of potential GWDTEs from NVC mapping data, the hydrological and hydrogeological desktop study information has been used to help qualitatively determine the potential sensitivity of each potential GWDTE.

1.3.3 Further details with regard to each GWDTE identified are provided in Table 10.1.1. The sensitivity of each of the GWDTE receptors has been classed, based upon classifications provided within SEPA's guidance document LUPS4[4].

National Vegetation Classification

1.3.4 A number of potential habitat areas with the potential (on the basis of NVC data only) to be Moderately and Highly GWDTE were identified during the NVC surveys conducted by Alba Ecology Ltd in September 2020**Error! Bookmark not defined.**. Further details with regard to each GWDTE identified are provided below.

1.3.5 The following NVC communities which are classified as potentially groundwater dependent according to the SEPA guidance LUPS – GN31[5] were recorded:

[2] National Soil Map of Scotland: https://map.environment.gov.scot/Soil_maps/?layer=1

[3] Available at British Geological Society: https://www.bgs.ac.uk/datasets/hydrogeological-maps-of-scotland/

[4] Scottish Environment Protection Agency, Land Use Planning System SEPA Guidance Note 4, Planning guidance on on-shore windfarm developments, Version 7, May 2014

[5] Scottish Environment Protection Agency, 2017. Land Use Planning System SEPA Guidance Note 31, Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems

- M6 *Carex echinate – Sphagnum fallax* mire;
- M10 *Carex dioica – Pinguicula vulgaris* mire;
- M15 *Trichophorum cespitosum – Erica tetralix* wet dwarf-shrub heath;
- M23 *Juncus effusus/acutiflorus – Galium palustre* rush-pasture; and
- M25 *Molinia caerulea – Potentilla erecta* mire.

1.3.6 These NVC communities are mapped in Figure 10.1.5. Of the potentially groundwater dependent communities identified in paragraph 1.3.5, the M6, M10 and M23 are considered to have a potential to be highly groundwater dependent, although this is dependent on the hydrological setting. The M15 and M25 communities are considered potentially moderately groundwater dependent, are also dependant on the hydrological setting. To understand the potential groundwater dependency of the recorded NVC habitats, Alba Ecology Ltd analysed the communities from an ecological perspective and summarised the hydrological setting of the habitats. Their findings are summarised in Table 10.1.

Table 10.1.1: Ecological Summary of Groundwater Dependent Terrestrial Ecosystems

Habitat	NVC Community	GWDTE Potential according to the SEPA Guidance	Comment on GWDTE Potential
Flush	M6	High	Usually small patches beside watercourses, likely influenced by ombrotrophic bog and surface water.
Flush	M10*	High	Several small communities located on hillslopes which indicates some base enrichment which can be associated with groundwater discharging from a spring.
Wet dwarf-shrub heath	M15	Moderate	Associated with hillslopes and lower slopes beside watercourses. Likely influenced by surface water runoff and rainfall.
Marshy grassland	M23	High	Streamside habitat associated with surface water movement likely influenced by ombrotrophic bog and surface water.
Marshy grassland	M25	Moderate	Associated with water movement within peat bog, and likely influenced by the bog.

*Only one M10 community is located within the site boundary and lies on the boundary of the site west of Loch Sgeireach.

1.3.7 Hydrological and hydrogeological desktop study information, as well as site specific conditions informed by the hydrological survey carried out in November 2020, have been used to further qualitatively determine the sensitivity of the M6 and M23 habitats

(potential for high groundwater dependency), as shown in Figure 10.1.6. The assessment includes consideration of:

- The direct hydrological connection of a potential GWDTE to surface water sources;
- Underlying geological conditions including the productivity of bedrock and superficial geology, the presence of peat soils and permeability of upgradient geology; and
- Topography and the presence of rills or runnels indicative of surface runoff.

1.3.8 Table 10.2 summarises the species present in the areas of high GWDTE potential and the likely degree of dependency on the underlying groundwater body, according to site-specific hydrological conditions (Figure 10.1.6). Justification of the assessment of potential groundwater dependency is provided Table 10.1.2 and the sensitivity of the GWDTE based on the hydrological analysis is presented in Figure 10.1.7.

Table 10.1.2: Hydrological Review of High Potential Groundwater Dependent Terrestrial Ecosystems

GWDTE ID on Figures 10.1.6 & 10.1.7	NVC Communities Present	GWDTE Classification (SEPA GN 31)	Ramboll Groundwater Dependency Assessment	Justification
1	H10a:U5:M6c *Calluna vulgaris-Erica cinerea heath*	High	Not likely to be highly groundwater dependent	Direct connection to watercourse (source of Alltan Leacach) and a number of surface water drainage channels.
2	H10a:U4:M6a *Calluna vulgaris-Erica cinerea heath*	High	Not likely to be highly groundwater dependent	Direct connection to watercourse (Alltan Leacach).
3	M6a *Carex echinate-Sphagnum fallax/ denticulatum mire*	High	Not likely to be highly groundwater dependent	Direct connection to surface water drainage channel.
4	M6c *Carex echinate-Spagnum fallax/ denticulatum mire*	High	Not likely to be highly groundwater dependent	Direct connection to surface water drainage channel.
5	U5b:M6c *Nardus stricta-Galium saxatile grassland*	High	Not likely to be highly groundwater dependent	Located on a hillslope where a number of surface water drains originate and flow towards the Alltan Leacach.
6	M6c *Carex echinata-Sphagnum fallax/denticulatum mire*	High	Not likely to be highly groundwater dependent	Direct connection to watercourse (Allt Bad an t-Sagairt).
7	M6c *Carex echinata-Sphagnum fallax/denticulatum mire*	High	Not likely to be highly groundwater dependent	Direct connection to watercourse (Allt Bad an t-Sagairt).

GWDTE ID on Figures 10.1.6 & 10.1.7	NVC Communities Present	GWDTE Classification (SEPA GN 31)	Ramboll Groundwater Dependency Assessment	Justification
8	U5b:M6c *Nardus stricta-Galium saxatile grassland*	High	Not likely to be highly groundwater dependent	Direct connection to surface water drainage channel at the source of the Allt Bad an t-Sagairt.
9	M6c *Carex echinata-Sphagnum fallax/denticulatum mire*	High	Not likely to be highly groundwater dependent	Located near the course of an ephemeral stream at a likely surface water flow accumulation.
10	M6a *Carex echinata-Sphagnum fallax/denticulatum mire*	High	Not likely to be highly groundwater dependent	Located alongside deep peat hags which contain streams. Habitat likely influenced by ombrotrophic bog and surface water.
11	M6a *Carex echinata-Sphagnum fallax/denticulatum mire*	High	Not likely to be highly groundwater dependent	Located in close proximity to deep peat hags and areas of surface water runoff. Habitat likely influenced by ombrotrophic bog and surface water.
12	M6c *Carex echinata-Sphagnum fallax/denticulatum mire*	High	Not likely to be highly groundwater dependent	Located on a hillslope with surface water runoff and where a number of deep peat hags have formed which contain small streams. Habitat likely influenced by ombrotrophic bog and surface water.
13	M6c *Carex echinata-Sphagnum fallax/denticulatum mire*	High	Not likely to be highly groundwater dependent	Direct connection to stream located in a deep peat hag.
14	M6c *Carex echinata-Sphagnum fallax/denticulatum mire*	High	Not likely to be highly groundwater dependent	Located alongside a deep peat hag which contains a stream. Habitat likely influenced by ombrotrophic bog and surface water.
15	M6c *Carex echinata-Sphagnum fallax/denticulatum mire*	High	Not likely to be highly groundwater dependent	Direct connection to stream located in a deep peat hag.
16	M23b *Juncus effusus/acutiflorus-*	High	Not likely to be highly groundwater dependent	Direct connection to watercourse (Allt an Ràsail).

GWDTE ID on Figures 10.1.6 & 10.1.7	NVC Communities Present	GWDTE Classification (SEPA GN 31)	Ramboll Groundwater Dependency Assessment	Justification
	Galium palustre rush-pasture			
17	M23b *Juncus effusus/acutiflorus-Galium palustre* rush-pasture	High	Not likely to be highly groundwater dependent	Direct connection to watercourse (Allt an Ràsail).
18	M6c *Carex echinata-Sphagnum fallax/denticulatum* mire	High	Not likely to be highly groundwater dependent	Direct connection to watercourse.
19	M6c *Carex echinata-Sphagnum fallax/denticulatum* mire	High	Not likely to be highly groundwater dependent	Direct connection to watercourse.

1.4 Groundwater Dependency

1.4.1 UKTAG guidance (2004)[6] recognises that most "*water dependent terrestrial ecosystems lie along a continuum between always only groundwater dependent and always only surface water dependent […]. The source of water supply for some wetlands does not appear to be critical, therefore the task of identifying dependence upon groundwater is sometimes complex*".

1.4.2 SNIFFER (2007) guidance[7] states that the dependence of wetlands on groundwater bodies is a result of hydrological connectivity. The degree of dependency will vary depending on whether the wetland is underlain by a low productivity or high productivity aquifer and whether there is a hydrological linkage mechanism between groundwater and the surface wetland. Likelihood of dependency is based upon the following:

- High Likelihood: characterised by intergranular, high productivity drift aquifer and dominantly intergranular, highly productive aquifer;
- Moderate Likelihood: characterised by intergranular, moderate productivity drift aquifer and fractured, very low productivity aquifer; and
- Low Likelihood: characterised by intergranular, very low productivity drift aquifer and fractured, very low productivity aquifer.

[6] UK Technical Advisory Group on the Water Framework Directive: Guidance on the identification and risk assessment of groundwater dependent terrestrial ecosystems.
https://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Risk%20assessment%20of%20terrestrial%20ecosystems%20groundwater_Draft_210104.pdf
[7] SNIFFER (2007) WFD66 – Wetland Hydrogeomorphic Classification for Scotland. Edinburgh: SNIFFER

1.4.3 The underlying bedrock aquifer is assessed by the BGS to be of low productivity with flow virtually all through fractures and other discontinuities, with small amounts of groundwater in the near surface weathered zone and secondary fractures. Where drift deposits are present within the site, these would be of low productivity. Therefore, it is assumed that there is low likelihood of groundwater dependency for all the GWDTE's within the site, based on assessment of underlying hydrogeology.

1.4.4 The UKTAG (2004) guidance provides criteria for identification and inclusion of GWDTE's in the risk assessment process, based on complementary ecological and hydrogeological assessments. These criteria have been used to produce the following matrix (Table 10.3), which provides an identification of sensitive and potentially sensitive GWDTEs that require a qualitative assessment to ascertain the significance of the risks the Proposed Development poses to them.

Table 10.3: Matrix for Identification of Sensitive GWDTEs from Ecological and Hydrogeological Assessments

		Hydrogeological Assessment Groundwater Dependency Level		
		High Likelihood	**Moderate Likelihood**	**Low Likelihood**
Ecological Assessment of NVC Communities	**Highly Groundwater Dependent**	Sensitive GWDTE	Potentially sensitive GWDTE	Potentially sensitive GWDTE
	Moderately Groundwater Dependent	Potentially sensitive GWDTE	Potentially sensitive GWDTE	Not sensitive
	Not Groundwater Dependent	Potentially sensitive GWDTE	Not sensitive	Not sensitive

1.4.5 The ecological assessment of the recorded NVC communities within the site determined them to be either of no groundwater dependency or moderate groundwater dependency (Table 6 of the Alba Ecology Ltd report[Error! Bookmark not defined.]).

1.4.6 Due to underlying hydrogeological conditions, topography and land use (as specified in SNIFFER (2007) guidance[Error! Bookmark not defined.]), all potential GWDTE areas are identified in the site-specific assessment of NVC communities as not likely to be groundwater dependent. This is because the NVC communities identified are in connectivity with surface water drainage either through:

- Direct connectivity with a surface water feature e.g. a watercourse or ephemeral stream;
- Located on a hillslope where a number of surface water drains originate, indicating habitat dependency on overland surface water flows; or
- Are located in peatland habitats likely influenced by ombrotrophic bog and surface water.

1.4.7 Additionally, the underlying bedrock geology is considered to be a low productivity aquifer, and the superficial geology considered poorly draining therefore also indicating habitats are unlikely to be groundwater dependent.

1.4.8 Therefore, the habitats initially identify as having a potential to be GWDTE areas are considered not to be groundwater dependent and therefore **not sensitive**. They have, therefore, been excluded from further assessment.

1.5 Mitigation and Further Assessment

1.5.1 As the potential GWDTE areas assessed are not considered likely to be highly groundwater dependent, specific mitigation with respect to groundwater supplies are not considered to be applicable.

1.5.2 None of the proposed turbine, hardstanding, welfare facility or borrow pit areas intersect with habitats identified as potentially groundwater dependent.

1.5.3 The track to T8 crosses through a habitat identified as potentially groundwater dependent through the NVC survey. This comprises an area of M6c - *Carex echinata-Sphagnum fallax/denticulatum mire* habitat but which is directly connected to a stream located in a deep peat hag and was, therefore, not considered a groundwater dependent habitat. It is considered that the maintenance of quality and quantity in surface water distribution across this area will be important, such that the condition of habitat which is not directly affected by the proposed track is maintained.

1.5.4 Suitable drainage and surface water measures would be used to maintain hydrological connectivity in peatland and wetland habitats. These measures would aim to prevent deleterious impacts on surface water distribution and would be addressed in the final CEMP to be prepared by the appointed contractor.

1.5.5 The locations assessed are in connection with wider peat bog and mire habitats present across the wider site. As such, it is considered that the maintenance of quality and quantity in surface water distribution across these areas will be important for the protection of habitats. Suitable drainage and surface water measures would be used to maintain hydrological connectivity in peatland and wetland habitats and prevent deleterious impacts on surface water distribution, which would also be addressed in the final CEMP to be prepared by the appointed contractor. Mitigation measures would include those presented in an Outline CEMP and would cover the following:

- Avoidance of direct impact by construction activity in such areas;
- Demarcation of the most sensitive habitat areas identified in the ecological survey (e.g. the areas of M23 and MG10 habitat) avoidance of further direct impacts by construction related activities (e.g. vehicle movements and material storage) and monitoring of works in close proximity to these sensitive areas by the Ecological Clerk of Works (EcoW);
- Implementation of Sustainable Drainage System (SuDS) measures to maintain quality of water supply;
- Maintenance of flow paths/redistribution of water where diverted; and
- Implementation of pollution prevention and control measures.

1.5.6 It is anticipated that habitat restoration, presented in the Outline Habitat Management Plan (HMP) would present the improvement of peat bog habitats.

T01
T02
T03
T04
T05
T06
T07
T08
T09
T10
T11
T12
T13
T14
T15
T16
T17
T18
Beinn Sgeireach
Loch Sgeireach
Cnoc Leacach
Meall Lonn
Coire Buidhe
Carn nam Bo Maola
Creag Bad a' Chreamha
Bad a' Chreamha
Glen Cassley
Glencassley Castle
Loch an Rasail
Loch Sheila
Sheepfold
Croich
Badintagairt
Sheep Wash
Ford
Grudie Burn

sse Renewables

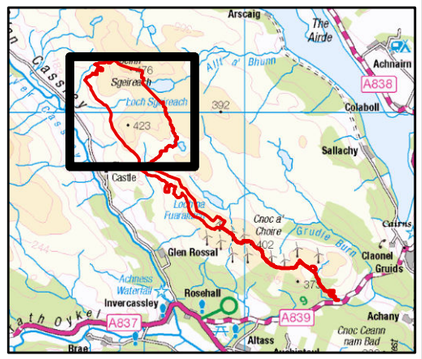
RAMBOLL

Key

- Site Boundary
- Turbine
- LiDAR Compound Location
- Floated Track
- Founded/Cut Track
- Substation, Welfare Facility and Store
- Temp. Construction Compound, Security, Storage and Batching Plant
- Hardstanding
- Borrow Pit Search Area

Bedrock Geology

Morar Group - Psammite	*Morr-psamm*



Scale 1:20,080 @ A3

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Figure 10.1.1a

Bedrock Geology

Achany Extension Wind Farm EIA Report