Technical Appendix 8.5: Groundwater Dependent Terrestrial Ecosystems (GWDTE) Assessment

Glentarken Wind Farm

SSE Renewables

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1.0 Introduction

SLR Consulting Ltd (SLR) was commissioned by SSE Renewables Services Ltd ('the agent') on behalf of SSE Generation Ltd (the 'Applicant'), to undertake an assessment of potential areas of Groundwater Dependent Terrestrial Ecosystems (GWDTEs) for the proposed Glentarken Wind Farm (the Proposed Development).

A number of surveys, including a programme of peat depth probing, a Phase 1 habitat survey and a National Vegetation Classification (NVC) mapping exercise has been undertaken and used to inform this assessment.

The Phase 1 habitat and NVC surveys were undertaken as part of the ecological baseline assessment and included all the infrastructure associated within the Proposed Development and a survey buffer of at least 250 m to this.

This Technical Appendix (TA) should be read in conjunction with the following Chapters and TAs of the Environmental Impact Assessment (EIA) Report:

- **Chapter 7: Ecology (EIAR Volume 1)** and **TA 7.1 (EIAR Volume 4)**, which contains a detailed description of the NVC survey undertaken and survey methodology;
- **Chapter 8: Geology, Peat, Hydrology and Hydrogeology (EIAR Volume 1)**, which contains a detailed description of the local hydrology and hydrogeological, water flow mechanisms and hydraulic properties of the soils and geology, the embedded mitigation incorporated in the development design and an assessment of impacts on groundwater and surface water flows and quality; and
- **TA 8.1: Peat Landslide Hazard and Risk Assessment (PLHRA) (EIAR Volume 4)** which contains details of the peat survey and recorded depths as well as details of the substrate recorded beneath the soils and peat.

1.1 Survey Area Description

The survey area comprises rough hill pasture, heathland and moorland. Ground elevations within the Site range from approximately 100m Above Ordnance Datum (AOD) along the southern boundary of the Site near Loch Earn to approximately 700m AOD near the summit of Creag Ruadh within the north eastern extent of the Site. Elevations generally decrease southwards towards the banks of Loch Earn.

1.2 Conceptual Hydrological Site Model

The following conceptual hydrological site model has been developed and is discussed in more detail in **Chapter 8: Geology, Peat, Hydrology and Hydrogeology (EIAR Volume 1)**:

- the Proposed Development is in an area that receives frequent rainfall and has a high annual rainfall total;
- where there are no drift deposits present, there is potential for some shallow groundwater to be present in the upper weathered surface of the bedrock. This is generally on elevated steeply sloping ground where rainfall would preferentially form surface water runoff and thus limit potential for infiltration to form groundwater;
- where shallow groundwater flow does occur in the weathered bedrock deposits it will follow topography; and
- the potential for rainwater recharge to groundwater within the bedrock is limited by (a) the presence regionally of peat, clays associated with glacial till and morainic deposits, and (b) the low bulk permeability of the bedrock. Incident rainfall is likely to

preferentially pond on the ground surface and where surface gradients allow form surface runoff or shallow interflow within the acrotelm (top) layer of the peat rather than infiltrate and form significant groundwater recharge.

The absence of significant quantities of groundwater in the superficial and bedrock deposits is confirmed by published mapping (see **Chapter 8: Geology, Peat, Hydrology and Hydrogeology (EIAR Volume 1), Figure 8.6 (EIAR Volume 2) and Figure 8.7 (EIAR Volume 2)**).

2.0 NVC Mapping and Occurrence of Potential GWDTE

2.1 NVC mapping

The survey methodology and findings are discussed in detail in **Chapter 7: Ecology (EIAR Volume 1)** and **TA 7.1 (EIAR Volume 4)**.

The NVC survey was undertaken in accordance with standard methodologies and guidelines, during which NVC communities were mapped in the field by applying polygons around visible boundaries of homogeneous vegetation or mosaic and /or transitional communities. Where readily identifiable, stands were classified and mapped at sub-community level.

Target notes were taken to record habitats and any specific features too small to map.

2.2 Occurrence of Potential GWDTE

The assessment of GWDTE began by identifying the NVC communities which are cited in the SEPA LUPS-31 guidance[1]

Four categories have been used to classify GWDTE areas:

- Highly Dominant, where potential high GWDTE habitat dominates the polygon (over 50% of the polygon);
- Highly Sub-dominant, where high GWDTE habitat makes up a sub-dominant percentage of the polygon (less than 50% of the polygon);
- Moderately Dominant, where potential moderate GWDTE dominate the polygon (over 50% of the polygon) and no potential high GWDTE habitat is present; and
- Moderately Sub-dominant, where potential moderate GWDTE habitat makes up a sub-dominant percentage of the polygon (less than 50% of the polygon) and no potential high GWDTE habitat is present.

In addition, and as discussed in **Chapter 7: Ecology (EIAR Volume 1)**, areas of Juncus Acutiflorus (JA) and Juncus Effusus (JE), which are not included in SEPA guidance, have been considered as a potentially moderate GWDTE community.

Using this approach, habitats determined to have a potentially moderate or high groundwater dependency are shown on **Figure 8.8 (EIAR Volume 2)**. Further site-specific scrutiny of these areas in terms of topography and hydrological context are discussed in the sections below.

2.2.1 Habitats with Potential Moderate Groundwater Dependency

Table 1 discusses habitats of potential moderate groundwater dependency which dominate the polygon and are cited in SEPA guidance. As discussed above, it also includes areas of JA and JE which have been considered as a potentially moderate GWDTE community.

Table 1: Potential Moderate Groundwater Dependency Habitats

NVC Community	Location	Discussion
M15	Extensive areas across the Site, particularly within the	The habitat is generally located on sloped ground located near watercourses or

[1] SEPA (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. Version 3.

NVC Community	Location	Discussion
	western extent of the Site near the proposed access track.	underlain by low permeability bedrocks or till and morainic deposits. The habitat is not rare and is presented across large areas of Scotland. This distribution is typical of that sustained by surface water rather than emergent groundwater.
M25	M25 dominant polygons are noted within the western extent of the Site near Beich Burn and proposed borrow pit search area BP6.	The habitat is underlain by low permeability till and morainic deposits. The low permeability of the deposits will allow local water logging of soils in response to rainfall rather than being sustained by emergent groundwater.
MG10	MG10 dominant polygon is noted within the western extent of the Site near Beich Burn	The habitat is underlain by low permeability till and morainic deposits. The low permeability of the deposits will allow local water logging of soils in response to rainfall rather than being sustained by emergent groundwater.
U6	U6 dominant polygons are noted in linear polygons across the Site.	U6 dominant polygons are generally located on sloped ground near watercourses or underlain by low permeability bedrock or till and morainic deposits. This distribution is typical of that sustained by surface water rather than emergent groundwater.
JA / JE	JA and JE dominant polygons are located outside of the Site Boundary near the Glentarken Burn	No development is located within 250 m of the habitats and therefore these are not considered further.

Table 1 shows that habitats of potential moderate groundwater dependency cover large areas over a range of elevations and slopes, underlain by low permeability deposits or in areas adjacent to watercourse channels. This distribution is not typical of that which is sustained by emerging groundwater, such as springs or seepage lines.

2.2.2 Habitats with Potential High Groundwater Dependency

Table 2 details areas of potential high groundwater dependency habitats which dominate the polygon, and which are cited in SEPA guidance.

Table 2: Potential High Groundwater Dependent Habitat

NVC Community	Location	Discussion
M23	Extensive areas across the Site, particularly within the western extent of the Site near the proposed access track and south of the proposed turbines.	The habitat is generally located on sloped ground located near watercourses or underlain by low permeability bedrocks or till and morainic deposits. This distribution is typical of that sustained by surface water rather than emergent groundwater.
M6	M6 dominant polygons are generally noted on sloped ground adjacent to and along the banks of the watercourses within the Site.	Given this location likely to be sustained by surface water and waterlogging of soils from rainfall and surface water.

NVC Community	Location	Discussion
W4	W4 dominant polygons are located within the southern extent of the Site adjacent to the proposed access track.	The habitat is underlain by low permeability till and morainic deposits. The low permeability of the deposits will allow local water logging of soils in response to rainfall rather than being sustained by emergent groundwater.
W7	W7 dominant polygons are located within the south western extent of the Site near the proposed access track.	The habitat is generally located adjacent to watercourses and are underlain by low permeability till and morainic deposits. This distribution is typical of that sustained by surface water rather than emergent groundwater.

Table 2 confirms that areas of potential high groundwater dependency habitat either coincide within watercourse corridors or are underlain by low permeability deposits and bedrocks. This distribution is not typical of a habitat sustained by groundwater. Linking the evidence from the field survey to the conceptual hydrological model, it is concluded that the dominant vegetation is predominantly supported by rainfall, surface water runoff and water logging of soils rather than by groundwater. These habitats are therefore not considered to be sustained by groundwater, and buffers to these in SEPA guidance need not apply. Safeguards will however be required to maintain existing surface water flow paths and water quality.

In addition to the highly dominant habitats described in Table 2, the following potentially high groundwater dependency habitats were recorded as part of highly sub dominant habitats within the NVC survey:

- CG10. CG10 is present within one habitat mosaic which has been classified as highly sub dominant. The habitat is located outside of the Site Boundary, approximately 440m south of the Site. No development is located within 250 m of the habitats and therefore it is not considered further.
- M10. M10 habitats are considered flush features which are at least partially supported by groundwater. M10 habitats within the Site are located within habitat mosaics which have been classified as highly sub-dominant approximately 220 m southeast of borrow pit search area BP1. This habitat is underlain by igneous bedrocks and no superficial deposits have been mapped by BGS. No development is proposed upgradient of the habitat and therefore it is considered that the water source which supports this habitat will not be at risk from the Proposed Development.
- M32. M32 habitats are also considered flush features which are at least partially supported by groundwater, although it is noted that these habitats are common and widespread across Scotland. M32 is located within habitat mosaics which have been classified as highly sub-dominant. No development is located within 250 m of these habitats.

In addition, three target notes of M10 and three target notes of M32 have been identified in the NVC survey. Three of these target notes are recorded within 250 m of the Proposed Development, as shown on **Figure 8.8 (EIAR Volume 2)**:

- one M10 flush (target note TN24) is located approximately 175 m northeast of turbine T21. No other development is located within 250 m of the spring. The spring is noted northeast (upstream) of the turbine and at an elevation approximately 20m higher than the turbine. It is therefore considered that the water source which supports this habitat will not be at risk from the Proposed Development.

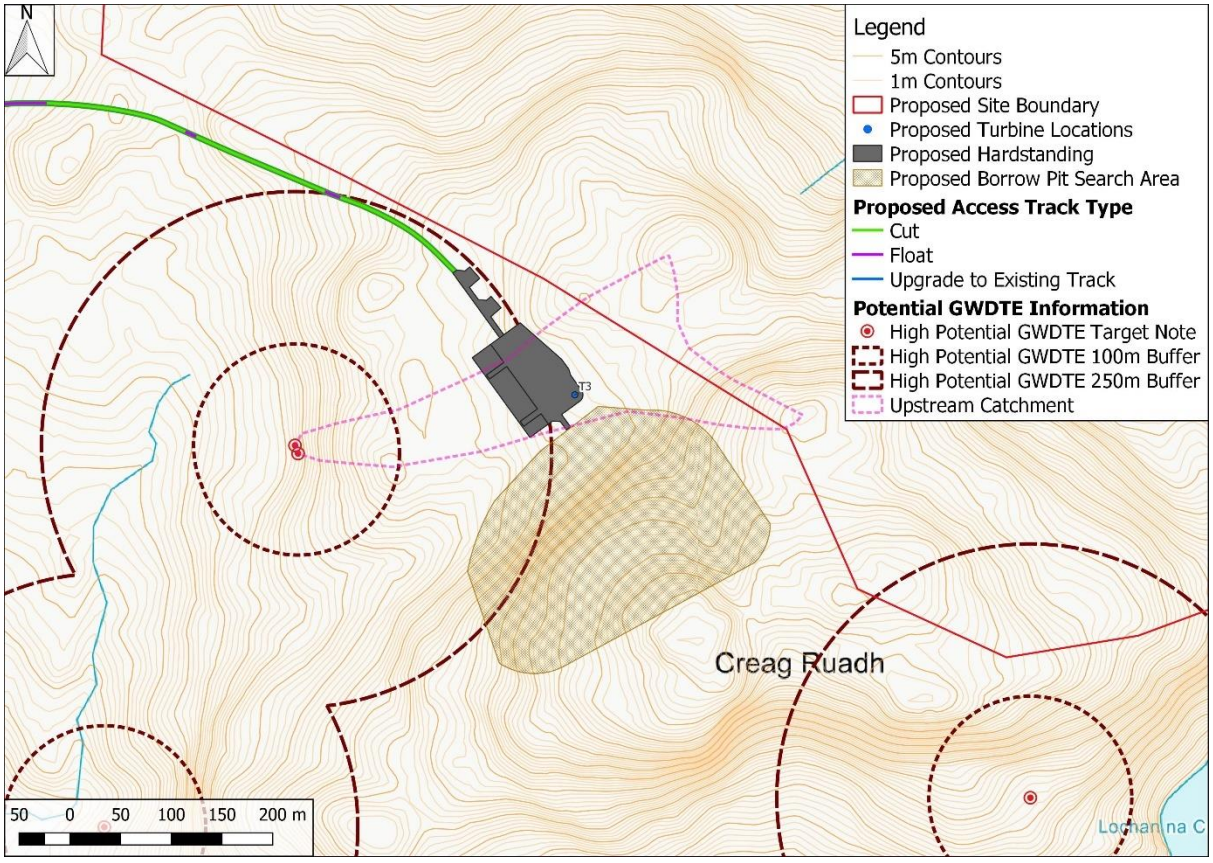
- two M32 flushes (target notes TN25 and TN26) are located approximately 195 m southwest of turbine T3. It is noted that there is a potential for the Proposed Development to impair the recorded M32 flushes as a result of intercepting or diverting water which flows to and sustains the habitat / flush.

It is therefore considered that, with the exception of the two M32 flushes, CG10, M10 and M32 are not at risk from the Proposed Development. Further assessment of the M32 springs which might be impaired by the Proposed Development is discussed below.

2.2.3 M32 Flushes

The upstream catchment of the M32 springs has been delineated using 5 m resolution OS Terrain 5 digital terrain model (DTM)[2]. 1 m and 5 m contours have been extracted from the DTM model and compared with OS 10m contours to delineate the upstream catchment. The upstream catchment is shown on Plate 2. The catchment is shown to extend to the north east of the springs. It is shown that the hardstanding associated with turbine T3 and a small area of the borrow pit search area is located within the upstream catchment. With reference to **TA 8.3: Borrow Pit Appraisal (EIAR Volume 4)** it is noted that the actual borrow pit is not proposed within the upstream catchment draining to the flushes.

Plate 1: M32 Flushes Water Catchment Area



It is therefore considered that turbine T3 has the potential, without safeguards, to impair the recorded M32 flushes.

The desk-based assessment has confirmed that limited groundwater is anticipated within the underlying geology by virtue of its low bulk permeability. No permanent dewatering or

[2] OS Terrain 5m data, available to download from https://www.ordnancesurvey.co.uk/products/os-terrain-5

groundwater management is required as part of the Proposed Development and therefore no permanent change to groundwater levels and flow direction will occur. Any existing groundwater contribution to habitats will therefore continue.

To ensure existing water flow paths are maintained during and following construction all works will be supervised by the project Environmental / Ecological Clerk of Works (ECoW) who will have authority to direct the Principal Contractor and oversee the installation of drainage measures that will maintain existing water flow paths; examples of the measures that might be deployed include cross drains, installation of site won aggregate that allows the movement of shallow interflow and drainage outfalls downstream of the proposed infrastructure within the surface water catchment area above the potential GWDTE habitat. With these measures, no effect on the M32 flushes within 250 m of turbine T3 is expected.

Should any additional GWDTE flushes be identified during construction, the ECoW will be responsible for ensuring existing surface water flow paths and water flushes are maintained.

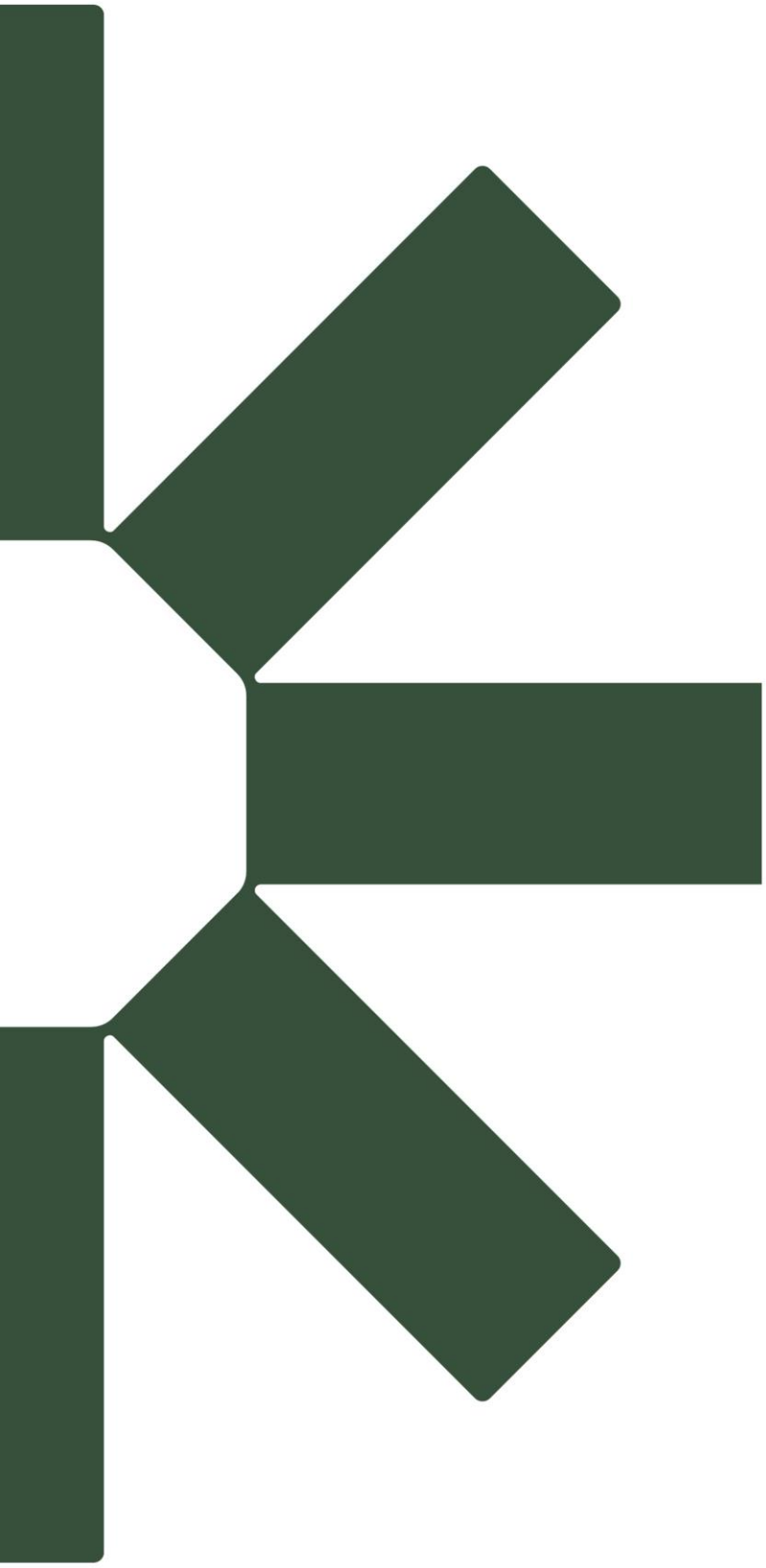
3.0 Summary

Review of **Figure 8.8 (EIAR Volume 2), Table 1** and **Table 2** confirms that the majority of potential groundwater dependent habitats are typically located over large areas, underlain by low permeability bedrock and superficial deposits or in/adjacent to watercourse corridors. This distribution is not consistent with habitats sustained by groundwater but rather habitats predominantly sustained by a high average annual rainfall, surface water runoff and surface water ponding.

It is concluded therefore that buffers to potential high and moderate GWDTE specified in SEPA guidance need not apply in these instances, but safeguards will be required during construction to maintain existing surface water flow paths to these habitats.

A number of flush habitats, which are at least partially supported by groundwater, have been recorded by the NVC survey. Two M32 flushes have been determined to be at risk of the Proposed Development, without appropriate safeguards, associated with hardstanding of turbine T3.

Examples of proposed safeguards which will be used to maintain existing surface water flow paths and maintain existing water quality are provided in **Chapter 8: Geology, Peat, Hydrology and Hydrogeology (EIAR Volume 1)**. A commitment has been made to include these in the final CEMP. It also includes the provision of an ECoW to supervise construction works with the authority to ensure that suitable cross drainage measures are implemented during the construction phase of the project. With these measures, no effect on the M32 flushes within 250 m of turbine T3 is expected.



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