



Technical Appendix 9.1: Groundwater Dependent Terrestrial Ecosystems (GWDTEs) Assessment

Balgray Wind Farm

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1.0 Introduction

SLR Consulting Ltd (SLR) was commissioned by Fred. Olsen Renewables Ltd (the Applicant) to conduct an assessment of potential areas of Groundwater Dependent Terrestrial Ecosystems (GWDTEs) for the Proposed Development.

A National Vegetation Classification (NVC) habitat mapping exercise has been conducted as part of the ecology baseline assessment, and this has been used to identify potential areas of GWDTE within the site. The methodology and results of the NVC habitat mapping exercise are discussed in detail within **Chapter 8: Ecology** of the EIA Report.

Areas of potential GWDTE are shown on **Figure 9.8**.

This Technical Appendix should be read in conjunction with **Chapter 9** of the EIA Report which contains a detailed description of the local hydrology and hydrogeology, 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.

1.1 Assessment Methodology and Report Structure

As required by SEPA's guidance the assessment has been undertaken by suitably qualified and experienced specialists.

The assessment has been undertaken with reference to Scottish Environment Protection Agency (SEPA) guidance¹ which sets out SEPA's expectations for the assessment of impact of developments on GWDTEs. This guidance applies to all developments requiring an Environmental Impact Assessment (EIA) provided any temporary or permanent dewatering abstractions are unlikely to exceed 10 m³/day.

SEPA recommends adopting a phased approach to the assessment of risks to groundwater abstractions, with greater detail being required for higher risk sites or activities, and identify the steps given in **Table 1**.

Table 1: SEPA Methodology – Assessment Steps

Step	Description
1	<u>Identify any GWDTE features</u> The relevant buffer zones for GWDTE for all proposed infrastructure (provided expected dewatering rates do not exceed 10m³/day) are: a) 10m radius of all activities; b) 100m radius of all subsurface activities less than 1m in depth; c) 250m of all subsurface activities deeper than 1m. Habitat survey screening for potential GWDTE: Ecological survey(s) are required to identify whether any GWDTE are present within the above buffer zones. A Phase 1 habitat survey should be provided unless the developer is already aware that GWDTE are likely to be present. The guidance 'SNIFFER (2009) WFD95 – A Functional Wetland Typology for Scotland' may be used to identify wetland types, both within and outwith the site boundary, within the relevant buffer zones as a minimum (for the purpose of micro-siting a wider expanse may be surveyed).

¹ SEPA (2024) Guidance on Assessing the Impacts of Developments on Groundwater Dependent Terrestrial Ecosystems



Step	Description
	If Phase 1 habitat survey results indicate that there may be relevant habitats present, a National Vegetation Classification (NVC) survey should be provided. A list of NVC communities that may be dependent on groundwater is included in Appendix B. Wetlands containing these communities should be considered to be GWDTE unless further information can be provided to demonstrate this is not the case. Developers can choose to undertake the NVC survey without a Phase 1 habitat survey should they consider it likely that GWDTE are present within the buffer zones. NatureScot holds some information on the occurrence of GWDTE, predominantly within designated sites (SSSIs, SPAs and SACs). However, there are non-designated wetlands that include GWDTE that are not listed. To identify non-designated GWDTE, refer to the guidance set out in 'SNIFFER (2009) WFD95 – A Functional Wetland Typology for Scotland'. Assessing groundwater dependency: Assessment is required to determine whether the potential GWDTE features identified are likely to be dependent on groundwater, either year around or seasonally. The interpretation should consider both ecology and hydrogeology. Groundwater dependency should be assessed on a site-specific basis for each potential GWDTE feature identified. Relevant factors include botanical communities present, local ground conditions, topography, and surface drainage. The interpretation should include assessment of the likely rooting depths relative to the water table, including potential seasonal variations. Groundwater dependence should be assumed for the NVC communities listed in Appendix B unless there is clear evidence to the contrary. Features that are indicative of groundwater dependency include: • Habitats associated with springs • Where soils are persistently waterlogged on otherwise well drained steep to moderate slopes, in the absence of surface water sources • Upper edge of GWDTE is aligned with concave breaks in slope • Diffuse groundwater emergence is often focused along linear geological features (fractures, faults etc) • Persistent flow even during dry weather • Limited variation in temperature • May be base enriched If no potential GWDTE features are present in the area of interest, no further risk assessment is required. Otherwise, proceed to Step 2.
2	<u>Qualitative Impact Assessment</u> A conceptual site model (CSM) should be provided as part of the Environmental Statement. This should include interpretation of the hydrogeological setting, including the groundwater flow regime, and the ecological features present. This may be supported, as appropriate, by intrusive ground investigation, groundwater monitoring, or groundwater modelling in addition to topography, properties of the emergent water & the soil, and underlying geology. Qualitative assessment of the potential impacts to any GWDTE features identified within the relevant buffer zones is required. This should consider the expected extent, magnitude, likelihood, and duration, frequency and reversibility of any potential impacts. The impact assessment should consider the impacts to each GWDTE feature individually, including any potential cumulative effects if the GWDTE feature is in close proximity to multiple parts of the proposed development. An iterative approach is recommended, using the impact assessment findings to inform the design process. Consider modifying the development proposals to avoid potential impacts as far as possible (i.e. by moving proposed activities outwith the relevant buffer zones).



Step	Description
	If the potential impacts to GWDTE are Low or Unimportant, then no further risk assessment is required. Otherwise, proceed to Step 3.
3	<u>Detailed Quantitative Risk Assessment</u> This is expected to be supported by appropriate characterisation of the ground conditions at both the relevant infrastructure location(s) and the GWDTE(s), plus the pathway(s) in between if appropriate. This will require ground investigation, including groundwater level and quality monitoring. The hydrogeological assessment should quantify the potential change(s) in groundwater levels or flow regime, and/or groundwater quality. The modelling approach, input parameters and assumptions should be justified. The hydrogeological modelling predictions should inform the assessment of the ecological risks to the GWDTE. If the quantitative risk assessment confirms the potential impacts are Major or Medium, then provide details of the site-specific mitigation measures proposed to avoid or offset the potential impacts. The nature of the mitigation measures required will depend on both the development and the GWDTE. Consultation with SEPA, and other relevant stakeholders as appropriate (e.g. NatureScot), may be beneficial when developing site-specific mitigation measures. Then refine the quantitative risk assessment to confirm whether any residual impacts to GWDTE remain once the proposed mitigation measures are in place. If the assessment proceeded to Step 3, then monitoring is required to demonstrate the effectiveness of the proposed site-specific mitigation measures developed during Step 3.

The areas of potential GWDTE, as identified in the NVC survey, and an assessment on their potential groundwater dependency is presented in Section 2 of this report, in accordance with Step 1 of the SEPA guidance. If any potential GWDTE areas are considered to be groundwater dependent, a qualitative risk assessment has been completed and is presented within Section 3 of this report (Step 2 of the SEPA guidance).



2.0 Groundwater Dependent Terrestrial Ecosystem Assessment (Step 1)

2.1 Site Setting

The Proposed Development is located approximately 6km northeast of Lockerbie in Dumfries and Galloway. Ground elevations across the Proposed Development Site generally range from approximately 170m Above Ordnance Datum (AOD) within the northwestern extent of the Proposed Development Site along Hewke Burn and Hallhills Loch, to approximately 250m AOD within the eastern extent of the Proposed Development Site, at the summit of Firtree Hill.

As discussed in **Chapter 9** the following conceptual hydrological site model has been developed for the study area:

- 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 runoff and thus limit the 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 and clays associated with the glacial till 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.

2.2 NVC Mapping

The methodology and results of the NVC habitat mapping exercise are discussed in detail within **Chapter 8: Ecology** of the EIA Report.

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.

2.3 Occurrence of Potential GWDTE

Areas of potential GWDTE have been identified using the NVC communities which are cited in the SEPA guidance (see Annex B of the guidance) and are shown on **Figure 9.8**.

The location of potential GWDTEs and a discussion on their likely dependency on groundwater is discussed in **Table 2**.



Table 2: GWDTE Assessment

NVC Community	Distribution within the Study Area and Likely Groundwater Dependency
CG10	CG10 dominant polygon is noted within the southern extent of the site, approximately 100m southeast of the proposed access track. The polygon is underlain by low permeability metasedimentary bedrocks, which may have groundwater in the near surface weathered zone. The habitat was reviewed during the site visit and the area was noted as dry and no emerging water or springs were recorded. It is therefore considered that the habitat is sustained by surface water and waterlogging of soils from rainfall rather than groundwater. No further assessment is required.
M6	Two M6 dominant polygons are noted within the southeastern extent of the site. One polygon is located approximately 230m south of the proposed access track within the upper reaches of the Hope Burn. This habitat is also underlain by low permeability glacial till deposits. The other polygon crosses the proposed access track towards turbine T5. The habitat was reviewed during the site visit and no emerging water or springs were recorded. It is therefore considered that the M6 habitats within the site are sustained by surface water and waterlogging of soils from rainfall or adjacent to watercourses rather than groundwater. No further assessment is required.
M9	M9 habitats are considered flush features which are at least partially dependent on groundwater or base rich and/or calcareous waters. The habitat is recorded in two areas within the northern and eastern extent of the site: - Two M9 polygons are noted along the banks of Hillhills Loch whilst an additional polygon is noted south east of the confluence of the loch and Hewke Burn. Given the proximity of the watercourses and waterbodies it is likely that the habitat is predominately sustained by waterlogging of soils adjacent to the water network rather than emergent groundwater. In addition, no development is located upstream and within 250m of the M9 habitat. The watercourses will also act as a “hydraulic barrier” between the habitat and the proposed turbine (T2) which means that there is unlikely to be any hydraulic connectivity between the proposed turbine and any limited groundwater which may sustain the GWDTE habitat. - A M9 mosaic habitat is noted approximately 180m south west of turbine T6. The habitat covers a large area within the eastern extent of the site and is shown to be underlain by low permeability peat and glacial till deposits whereby limited groundwater is expected. It is therefore considered that the habitats are predominately sustained by waterlogging within the low permeability soils rather than emerging groundwater such as a spring. It is therefore considered that no further assessment of M9 habitats is required.
M10	M10 habitats are also considered flush features which are at least partially dependent on groundwater or base rich and/or calcareous waters. Three M10 habitats are noted across the eastern extent of the site: M10 dominant polygon which is located approximately 100m south of turbine T2. The polygon is located on upgradient slopes near the Hewke Burn and its tributary. BGS superficial mapping indicates that the habitat is shown to be underlain by low permeability glacial till deposits whereby limited groundwater is expected. It is therefore considered likely that the habitat is predominately sustained by surface water runoff and waterlogging of soils near the existing watercourses rather than



NVC Community	Distribution within the Study Area and Likely Groundwater Dependency
	groundwater. In addition, no development is located upstream and within 250m of the M10 habitat. The watercourses will also act as a “hydraulic barrier” between the habitat and the proposed turbine which means that there is unlikely to be any hydraulic connectivity between the proposed turbine and any limited groundwater which may sustain the GWDTE habitat. • M10 dominant polygons which is located east of turbine T1 and the proposed access track towards turbine T6. The habitat is located along a surface water flow path shown by SEPA which were confirmed by the site visit. It is therefore considered that the M10 habitat is predominately sustain the habitat rather than emergent groundwater. It is therefore considered that no further assessment of this M10 habitat is required. • An M10 and M37 mosaic habitat is located approximately 135m east of turbine T3. The polygon within the upper reaches of the Hope Burn, near the banks of a minor tributary of the burn. BGS superficial mapping indicates that the habitat is shown to be underlain by low permeability glacial till deposits whereby limited groundwater is expected. Given this distribution, it is likely the habitat is predominately sustained by surface water and waterlogging of soils adjacent to the watercourse rather than emergent groundwater. In addition, no development except for the proposed access track is located within 250m of the habitat. The proposed access track is located >100m from the habitat and given the excavations required for to establish the access track (<1m) it is therefore unlikely that the access track will impact any shallow groundwater flow which may sustain the habitat. It is therefore considered that no further assessment of M10 habitats is required.
M15	M15 dominant polygons and mosaic habitats are recorded across the eastern extent of the site. The habitats are located across the site at a range of different elevations, including local high points, and are underlain by low permeability glacial till and metasediment and sedimentary bedrocks where limited groundwater is anticipated. The habitats are also noted near existing watercourses and/or where surface water flow paths are shown by SEPA. It is noted that M15 habitats are not rare and is present across large areas of Scotland. Given the distribution seen at the site it is likely that the M15 habitats are predominately sustained by surface water runoff and waterlogging of soils, rather than by groundwater. No further assessment is required.
M23	M23 dominant polygons and mosaic habitats are recorded across the large portions of the site. The habitats are located across the site at a range of different elevations, including local hilltops, and are underlain by low permeability glacial till and metasediment and sedimentary bedrocks where limited groundwater is anticipated. The habitats are also noted near existing watercourses and/or where surface water flow paths are shown by SEPA. Given this distribution it is likely that the M23 habitats are predominately sustained by surface water runoff and waterlogging of soils, rather than by groundwater. No further assessment is required.
M27	M27 habitats within the site is located approximately 120m east of the proposed access track. The habitat is shown to be underlain by peat whereby limited groundwater is anticipated. The low permeability of the peat deposits will allow local water logging of soils in response to rainfall rather than being sustained by emergent groundwater. It is therefore considered that no further assessment of M27 habitat is required.



NVC Community	Distribution within the Study Area and Likely Groundwater Dependency
M37	M37 habitats are also considered flush features and are noted as part of a mosaic with M10 habitat within the south eastern extent of the site. As discussed above, it is considered that this habitat is sustained by surface water and waterlogging of soils adjacent to the watercourse rather than emergent groundwater. No further assessment is required.
MG9	MG9 habitats are noted within the northeastern extent of the site, generally located in linear polygons either adjacent to existing watercourses or along the existing access track. The habitats are located across the site at a range of different elevations, including local hilltops, and are underlain by low permeability glacial till and sedimentary bedrocks where limited groundwater is anticipated. Given this distribution is it considered that the habitat is sustained by high rainfall, surface water runoff and drainage along the existing track rather than groundwater. No further assessment is required.
MG10	MG10 habitats are noted across the site at a range of different elevations, including local hilltops, and are underlain by low permeability glacial till and metasedimentary bedrocks where limited groundwater is anticipated. The habitat is also noted along existing watercourses and/or where surface water flow paths are shown by SEPA. Given this distribution is it considered that the habitat is sustained by high rainfall, surface water runoff and waterlogging of soils. No further assessment is required.
W4	W4 habitat is noted outside of the site boundary, approximately 220m south of the proposed BESS. The polygon is underlain by low permeability glacial till deposits whereby limited groundwater is anticipated. The low permeability of the deposits will allow local water logging of soils in response to rainfall rather than being sustained by emergent groundwater. It is therefore considered that no further assessment of W4 habitat is required.
W7	W7 habitat is noted along the southern boundary of the site boundary, approximately 210m southwest of the proposed BESS. The polygons are underlain by low permeability glacial till deposits whereby limited groundwater is anticipated. The low permeability of the deposits will allow local water logging of soils in response to rainfall rather than being sustained by emergent groundwater. It is therefore considered that no further assessment of W7 habitat is required.

Table 2 shows that the areas of potential GWDTE are generally located on ground adjacent to watercourses or within existing surface water flow routes and underlain by either low permeability peat, glacial till and bedrock deposits. This distribution is not typical of that which is sustained by emerging groundwater, such as springs or seepage lines but rather it is likely to be supported by rainfall, surface water ponding and water logging of soils adjacent to watercourses or above the low permeability deposits.

It is therefore considered that the majority of potential GWDTE habitats are not sustained by groundwater. However, safeguards to maintain these habitats, and sustain the surface water flows and preserve water quality to these habitats, will need to be implemented during construction, operation and decommissioning of the Proposed Development, details of which are included **Chapter 9** of the EIA Report.



3.0 Qualitative Risk Assessment (Step 2)

This Section of the report provides further assessment of areas of potential GWDTE that have been identified to be groundwater dependent.

As discussed in **Table 2**, no further assessment on the areas of potential GWDTE is required.

3.1 Committed Mitigation

Chapter 9 of the EIA Report details the mitigation measures that would be deployed and used to safeguard the water environment and areas of GWDTE. Of relevant to this report and assessment are the following:

- the production of a final Construction and Environmental Management Plan (CEMP) which would be agreed with statutory consultees prior to commencement of any works;
- the adoption of good practice measures and appropriate drainage measures to safeguard existing surface water flow paths, shallow groundwater flow and maintain existing water quality; and
- the deployment of an Ecological Clerk of Works (ECoW) to oversee all works and with the authority to cease works should a risk to the water environment (e.g. change in water flow or quality) become apparent.



4.0 Summary and Conclusions

Review of **Figure 9.8** and **Table 2** confirms that the areas of potential GWDTE 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, surface water ponding and waterlogging of soils.

A number of flush habitats, which are at least partially supported by groundwater, have been recorded by the NVC survey. Given the location of these habitats, it is considered that they are also predominately sustained by surface water and waterlogging of soils rather than by emergent groundwater such as a spring or seepage line. Any groundwater which may sustain these habitats is also not considered to be at risk from the Proposed Development.

It is concluded therefore that buffers to these areas of potential 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.

Examples of proposed safeguards which will be used to maintain existing surface water flow paths and maintain existing water quality are provided in **Chapter 9** of the EIA. A commitment has been made to include these in the final CEMP, which also includes the provision of an ECoW.





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