Rigare
Groundwater and Wetland Science

Technical Memorandum

Rigare project #: 1747	Project: Proposed Mynydd Maen Wind Farm, Newbridge
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Subject: **E-H impact assessment & remediation on GWDTEs peat proposed Mynydd Maen Wind Farm (Rigare 1747_r1.4 January 2024)**	

1. Introduction

1.1 Overarching principle of hydrological neutrality

The aim of the wind farm design relating to construction, operation and de-commissioning will be, as far as possible, to achieve environmental hydrological neutrality in terms of water quantity and quality. This principle will apply in relation to all classes of potential hydrological impact receptor, including water resources (groundwater and surface water), ecohydrology (i.e., Groundwater-Dependent Terrestrial Ecosystems [GWDTEs] identified by BSG) and peat.

The approach has two elements:

1. Designing the wind farm to avoid/minimise hydrological impacts.
2. Where hydrological impacts are possible, designing and emplacing mitigation measures which will reproduce upslope hydrological processes downslope of the infrastructure, through:
    a. Excavation of necessary upslope drainage ditches, including upslope interception ditches at construction sites and upslope trackside drains where needed.
    b. Routing intercepted upslope runoff and seepage through the infrastructure in regular culverts.
    c. Excavation of downslope, contour-parallel recharge trenches as close to the infrastructure as possible. The intercepted water will flow into and pond evenly along the recharge trench, and either infiltrate into the ground downslope or overtop diffusely during significant rainfall events, the result being to reproduce the cross-slope distribution and nature of the hillslope hydrology.

    It is important to note that under this approach, the previous practice of directing intercepted clean water into nearby streams, or discharging it at discrete points on the downslope hillside, will not be used.

    d. Designing, excavating and maintaining a dirty water system, with appropriate treatment, within the infrastructure hydrological envelope, defined by a-c above.

1.2 Appropriate hydrological training

Relevant personnel would be fully trained in relation to the hydrology. Trainees would include excavator drivers, ecological clerks of works and long-term operators. From this training they will:

- Understand relevant hillslope hydrology, and the location of, and need to avoid impacts at, receptors.
- Understand the principle of hydrological neutrality laid out in Section 1.1 above.
- Be able to implement, diagnose operational problems with, and develop remedial measures for, the resulting systems.

2. Potential hydrology-related impact receptors

2.1 On-site water-dependent ecological features & habitats (GWDTEs)

On-site water-dependent ecological features and habitats were identified by BSG Ecology ecological consultants from the results of their ecological survey of the site (refer chapter 6 Ecology). The locations of these features are shown in Figures 6.9 a, b & c. They comprise:

- Acid/neutral spring/flush habitat (M23b with Sphagnum fallax).
- Marsh/marshy grassland (M23b).
- Ponds.
- Wet dwarf shrub heath (M25a).

The occurrence of these GWDTEs is not extensive across the site, but each stand has been taken into consideration in the impact assessment (Section 3).

The possible impacts on the water supply to, water retention within, and water discharge from, the GWDTEs was considered initially, with the intention that more detailed analysis would be undertaken if any potential impacts were identified (see Section 3).

2.2 Peat

Peat has been considered as a primary potential receptor for hydrological impacts. In good ecohydrological condition, peatlands can deliver a range of important ecosystem services, including carbon storage and greenhouse gas emission minimisation, biodiversity, natural flood management, and natural capital and human wellbeing.

An extensive peat survey has been carried out by SLR (refer Appendix 9.3), taking in over 2100 points within the red line boundary. This raw peat thickness data has been contoured using Surfer, and presented in the following classes in Section 3:

- 0-0.2 m.
- 0.2-0.3 m.
- 0.3-0.4 m.
- 0.4-0.5 m.
- >0.5 m.

It is firstly worth noting that there is relatively little peat within the site, compared with other sites further north-west in Wales and the rest of the UK. There is no obvious evidence of historical peat mining on the site, and the likely explanation for the limited amount of peat is that the site is climatically marginal for blanket mire development. The rainfall is relatively low because of its rain-shadow location to the east of the South Wales high ground, and its southerly location means that evapotranspiration is relatively high because of warmer temperatures. These two factors will have combined to result in relatively low water tables, which in turn mean that decomposition of organic matter is relatively high (but on balance slightly less) compared to its accumulation. South Wales is, in general, at the southerly margin of maps of blanket mire occurrence in Wales.

It is also worth noting that, unfortunately, the site is very likely to become more climatically marginal for blanket mire development and security under most climate change projections (e.g., the UK Meteorological Office's UKCP18 projections).

Figure 1 shows the overall distribution of peat over the OS 1:25,000-scale survey. In general, it occurs in two topographic settings:

- Across the highest flat ground which forms the tops of Mynydd Llwyd (to the north), Mynydd Twyn-glas (central) and Mynydd Maen (to the south). The main driving factor here is likely to be slow lateral drainage because of the low imposed hydraulic gradients. These peatlands are very likely to be mostly ombrogenous (i.e., dependent on rainfall for water supply).

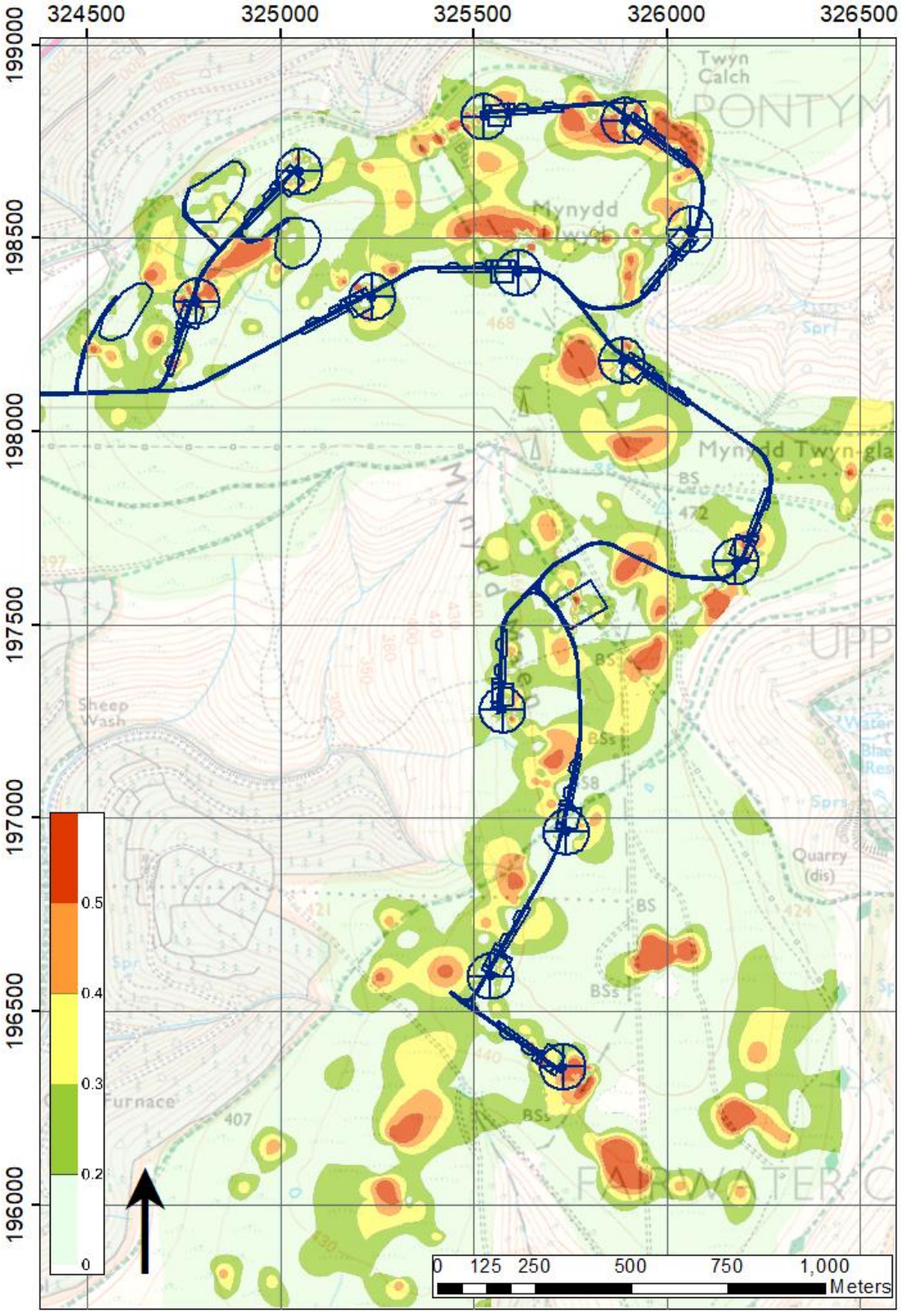

Figure 1. Overall distribution of peat thickness within the site.

- More extensively, on the flanks of the plateau, immediately upslope of where the ground falls away more steeply. The main driving factors here are relatively flat ground, which impedes drainage, but also receipt of runoff from upslope. These peatlands are likely to be somewhat terrigenous, i.e., partly sustained by surface runoff and shallow groundwater flow for water supply.

A critical peat thickness of 0.5 m was identified in the Scoping Direction provided by PEDW, but smaller thicknesses have been taken into account in Section 3, as appropriate.

The main favourable hydrological condition for peatlands is a high water table relative to the ground surface for the majority of the time. Any net hydrological impacts (i.e. after mitigation) which could lower the peatland water table should be avoided.

2.3 Other water features

Impacts on off-site water features, including water abstractions, are reported elsewhere (Chapter 9: Hydrology and Hydrogeology).

3. Ecohydrological impact assessment

An important general principle for the following impact assessments is that hydrological impacts tend only to extend a short distance (generally <5 m, and usually less) upslope, but can extend for much greater distances downslope (20-30+ m) without mitigation.

3.1 Turbines 1-3 and associated infrastructure

Turbines T1, T2 and T3 would be located close to the boundary of the gently sloping ground at the north-eastern edge of Mynydd Llwyd, in the north-eastern sector of the proposed wind farm (Figure 2[1]).

3.1.1 GWDTEs

There are no GWDTEs within the possible zone of hydrological influence of these turbines.

3.1.2 Peat

Turbine T1 is located within an area which hosts relatively extensive peat >0.4 m thickness, and some local cutting-down of the underlying mineral surface is likely to be required in order to achieve a level construction foundation.

There would be some direct loss of peatland within the footprint of T1 and associated infrastructure.

The deeper peat to the south-west of T1 (#1 in Figure 2) is less likely to be affected hydrologically by the construction as it lies upslope. The deeper peat to the east of the turbine and hard-standing (#2 in Figure 2) would be significantly affected by the proposed wind farm in the absence of mitigation as described in paragraph 1.1. The mitigation will need to be designed carefully as the deep peat is immediately adjacent to the proposed infrastructure.

It is recommended that water table monitoring (dipwells and automatic water level recorders [AWLRs] is carried out in both of these areas of deep peat.

Careful mitigation will also be required to safeguard the hydrological condition of the peat downslope of the access track between turbines T1 and T3 (#3 in Figure 2).

Turbine T2 and associated infrastructure are immediately downslope of local peat deposits, and therefore there are unlikely to be any significant hydrological impacts on the peat.

Turbine T3 is located within an area of discontinuous peat. The ground here slopes downwards to the north-west, so the peat to the south-west of the turbine (#4 in Figure 2) is very unlikely to be affected hydrologically by the proposed turbine.

Careful mitigation will be required to safeguard the hydrological condition of the small area of 0.3-0.5 m thick peat immediately to the north of the proposed turbine and hard-standing (#5 in Figure 2).

3.2 Turbines 4 & 5 and associated infrastructure

Turbine T4 is located around 50 m north of the summit of Mynydd Llwyd, within a large area of relatively flat ground.

[1] This and subsequent figures are included at the end of the document.

Turbine T5 is located on the east ridge of Mynydd Llwyd, although in practice it too is located within flat ground.

3.2.1 GWDTEs

There is a small area of wet dwarf shrub heath c. 70 m south of T4 (#1 in Figure 3). The general flatness of the ground in this area, and the small magnitude of any hydrological impact at source means that it is extremely unlikely that this area of GWDTE will be affected by the proposed wind farm.

There is a very small pond c. 70 m north-east of the closest part of the T5 infrastructure (#2 in Figure 3). The proposed infrastructure is aligned approximately along the ride (i.e., the watershed), and therefore it will not reduce the hydrological catchment to the pond.

3.2.2 Peat

Turbine T4 is located c. 60 m south of an area of deeper peat on Mynydd Llwyd (#3 in Figure 3). The peat is located marginally downslope of the proposed turbine infrastructure, but the slope of the ground is so low that it is considered unlikely to any great degree that the peat relies on shallow groundwater flow from the area of the proposed turbine to maintain water table elevation. It is likely to be overwhelmingly dependent on rainfall to support the water table. Therefore, it is considered highly unlikely that the proposed location of T4 will have a detectable hydrological impact on this area of deeper peat.

Turbine T5 is located within a small area of generally shallow peat (#4 in Figure 3). There is unlikely to be any hydrological impact on the peat to the south and south-east of the proposed turbine infrastructure, as the peat is mostly upslope.

There is a high risk that the hydrological condition of a very small area of deep peat immediately north of the proposed wind farm (#5 in Figure 3) will be affected; careful consideration of the design and implementation of mitigation measures will be required to avoid a significant impact.

3.3 Turbines 6 & 7, associated infrastructure, borrow pits & main access track

Turbines T6 and T7 are located on the north-west facing flank of Mynydd Llywd, which has a discontinuous cover of peat, with some small areas being greater than 0.5 m thick (Figure 4).

The main access track essentially follows the line of the eastern ride of Mynydd Llwyd in this area.

3.3.1 GWDTEs

The only GWDTEs in this area are elongated stands of marsh/marshy grassland to the north of the access track (#1 and #2 in Figure 4), and small ponds to the south of the access track (#3 in Figure 4). Since the access track follows the indistinct (in the field) ridge (i.e., watershed) it would not reduce the catchment to any of these GWDTEs, and therefore there is little chance of any hydrological impact on them.

Use of the prescribed mitigation measures on the access tracks to T6/T7 and the borrow pit (#4 in Figure 4) will ensure hydrological continuity is maintained between the areas of marshy grassland.

3.3.2 Peat

Turbine T6 and infrastructure is located immediately downslope of an elongate area of peat of varying depth (#5 in Figure 4), and therefore there is unlikely to be any significant impact on the peat.

The access track between T6 and T7 is located immediately downslope of a larger area of peat which is >0.4 m thick (#6 in Figure 4); there are unlikely to be any significant hydrological impacts on the deep peat from this track.

There is a proposed borrow pit immediately east of the area of deep peat, and there would be some direct loss of peatland caused by the construction of its access track. The access track is, however, downslope of the area of deeper peat (#7 in Figure 4) and will therefore have little hydrological impact on it.

There would be some direct losses of peatland from construction of T7 and associated infrastructure, and the access track to the borrow pit to its west (#4 in Figure 4). Careful implementation of hydrological mitigation should ensure that there are no significant hydrological impacts on areas of peat downslope (e.g., #8 in Figure 4).

3.4 Turbines 8 & 9, and associated infrastructure

Turbine T8 is on ground which gently slopes to the north-east, on the high saddle between Mynydd Llwyd and Mynydd Twyn-glas (Figure 5). Turbine T9 is located south-east of the top of Mynydd Twyn-glas, on ground which slopes gently south-eastwards.

3.4.1 GWDTEs

There is a significant area of wet dwarf shrub heath immediately west of T8 (#1 in Figure 5), which is approximately coincident with a small area of deeper peat. The proposed turbine location lies downslope of, and is therefore very unlikely to cause any significant hydrological impacts within, this area of GWDTE. Similarly, T8 is significantly downslope of, and would not cause any hydrological impact upon, the small pond to its south-west (#2 in Figure 5).

There are no GWTEs in the vicinity of T9.

3.4.2 Peat

Turbine T8, and its associated hard-standing and access tracks, lie within an area of relatively shallow peat, some of which would be lost directly by the construction. There are two areas of deeper (>0.4 m) peat (#3 and #4 in Figure 5) to the south-west of the infrastructure. The latter is downslope of, and is therefore very unlikely to cause hydrological impacts within, the former.

T9, and the long reach of access track to its west, would be constructed in an area with spatially discontinuous, but sometimes relatively deep, peat. Most or all of the small area of deeper peat which is coincident with T9 would be lost.

With careful design and implementation of mitigation measures, it would be possible to minimize hydrological impacts on the areas of deeper peat to the south of the access track (#5 and #6 in Figure 5), although there would be a small amount of direct loss of deep peat (#7 in Figure 5).

The area of deeper peat to the north of the access track (#8 in Figure 5) is cross-slope from the track, and would therefore not be affected hydrologically by the proposed wind farm.

3.5 Turbines 10 & 11, and associated infrastructure

Turbine T10 is located on westwards-sloping ground, west of the north-south-oriented ride between Mynydd Twyn-glas and Mynydd Maen, whilst T11 is located on ground which slopes only gently westward, on the central plateau of the same ridge.

The main access track to T11-T13 runs south immediately west of the highest ground of the ridge.

3.5.1 GWDTEs

GWDTEs in this area are limited to a small pond (#1 in Figure 6) on the opposite, eastern side of the summit ridge, and therefore in a different hydrological catchment. Hydrological impacts on this pond caused by the proposed wind farm can be ruled out.

3.5.2 Peat

There is discontinuous peat across the ridge plateau, with some extending downslope to the west.

T10 and associated infrastructure would be constructed in an area of peat, within which limited areas have thicknesses up to 0.5 m; some of this would be lost directly to the proposed wind farm. Some of the deeper peat lies immediately upslope of, or cross-slope from, the proposed turbine (#2 in Figure 6), and it should be possible to minimize hydrological impacts on this by careful design and/or micro-siting.

Hydrological impacts on the area of deeper peat on the opposite side of the ridge (#3 in Figure 6) can be ruled out because it is distant from the proposed infrastructure, and in a different catchment.

There is extensive peat, including small areas of deeper peat (e.g., #4 and #5 in Figure 6) downslope of the access track and T11. It would be possible to minimize hydrological impacts on this peat through careful design and implementation of mitigation (paragraph 1.1).

The area of deeper peat to the east of T11 (#6 in Figure 6) is upslope of the proposed turbine and its infrastructure, and therefore it is very unlikely to be affected hydrologically.

3.6 Turbines 12 & 13, and associated infrastructure

The proposed locations for T12 and T13 are both on the west side of the southern end of the Mynydd Maen ridge. A seasonally-flowing stream, which is probably fed by a discharge from the peat or a shallow groundwater body, lies c. 150 m south-west of T11 (#1 in Figure 7), flowing into a relatively incised valley.

3.6.1 GWDTEs

There are a number of GWDTEs in this wider area:

- An area of wet dwarf shrub heath, with ponds (#2 in Figure 7), lies on the flat ground on the ridge, upslope and c. 300 m east of the closest proposed infrastructure. It is coincident with an area of deeper peat. Since it is upslope it would not be affected hydrologically by the proposed wind farm.
- An area of wet dwarf shrub heath (#3 in Figure 7) lies to the west of the proposed location of T12. It is located on a slight spur from the Mynydd Maen ridge, and would almost certainly not be affected hydrologically by the proposed wind farm. It would definitely not be affected with the planned hydrological mitigation (see below).
- An area of wet dwarf shrub heath (#4 in Figure 7) lies to the south-west of the proposed location of T13 and its access track, on the other side of the small stream valley (#1 in Figure 7). From a topographic consideration, the area within which T13 and its access track are proposed cannot contribute water to this area of GWDTE, and therefore any hydrological impact can be ruled out.
- There are small acid/neutral spring flushes coincident with the heads of the seasonal springs c. 100 m south-west of the proposed location of T13 (#5 in Figure 7). It will be possible to avoid or minimise any hydrological impacts on these features by careful design and implementation of mitigation.

3.6.2 Peat

There is extensive peat downslope of T12 and the access tracks, with small areas of deeper peat (e.g., #6 and #7 in Figure 7). It would be possible to avoid any hydrological impacts on this peat by careful design and implementation of mitigation measures.

There would be direct loss of small areas of deeper peat through the construction of T13, but the nearby area of deeper peat, to the south-east (#8 in Figure 7), is cross-slope and therefore any hydrological impact from the construction is unlikely.

4. Ecohydrological impact assessment on GWDTEs & peat: Summary

The wind farm has been designed, and would be constructed, under the overarching principle of hydrological, and by extension ecohydrological, neutrality. The overall design of the wind farm is aimed at minimizing hydrological impacts by placing infrastructure on topographic ridges (i.e. no-flow boundaries) and higher, flat areas.

Where primary hydrological impacts are likely, careful design and implementation of mitigation measures would ensure that impacts are avoided or minimized. The main mitigation technique would be to route water which is intercepted upslope of the infrastructure under tracks, via frequent culverts, and then to redistribute it across the slope below the infrastructure. The aim is to reproduce, downslope, the hillslope hydrology upslope of the infrastructure.

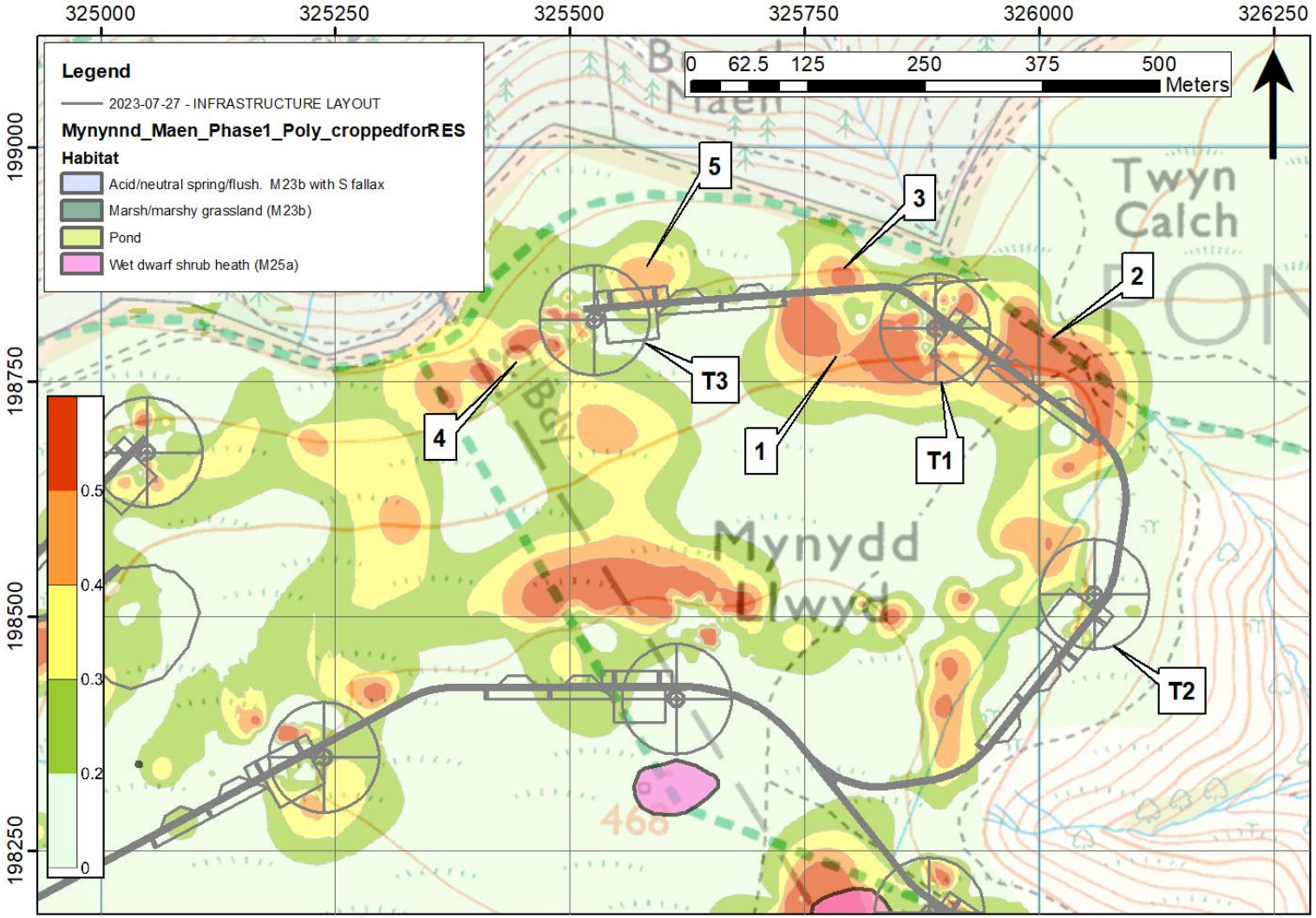

Figure 2. Annotated plan showing peat thickness and occurrence of GWDTEs in the vicinity of proposed Turbines T1-3.

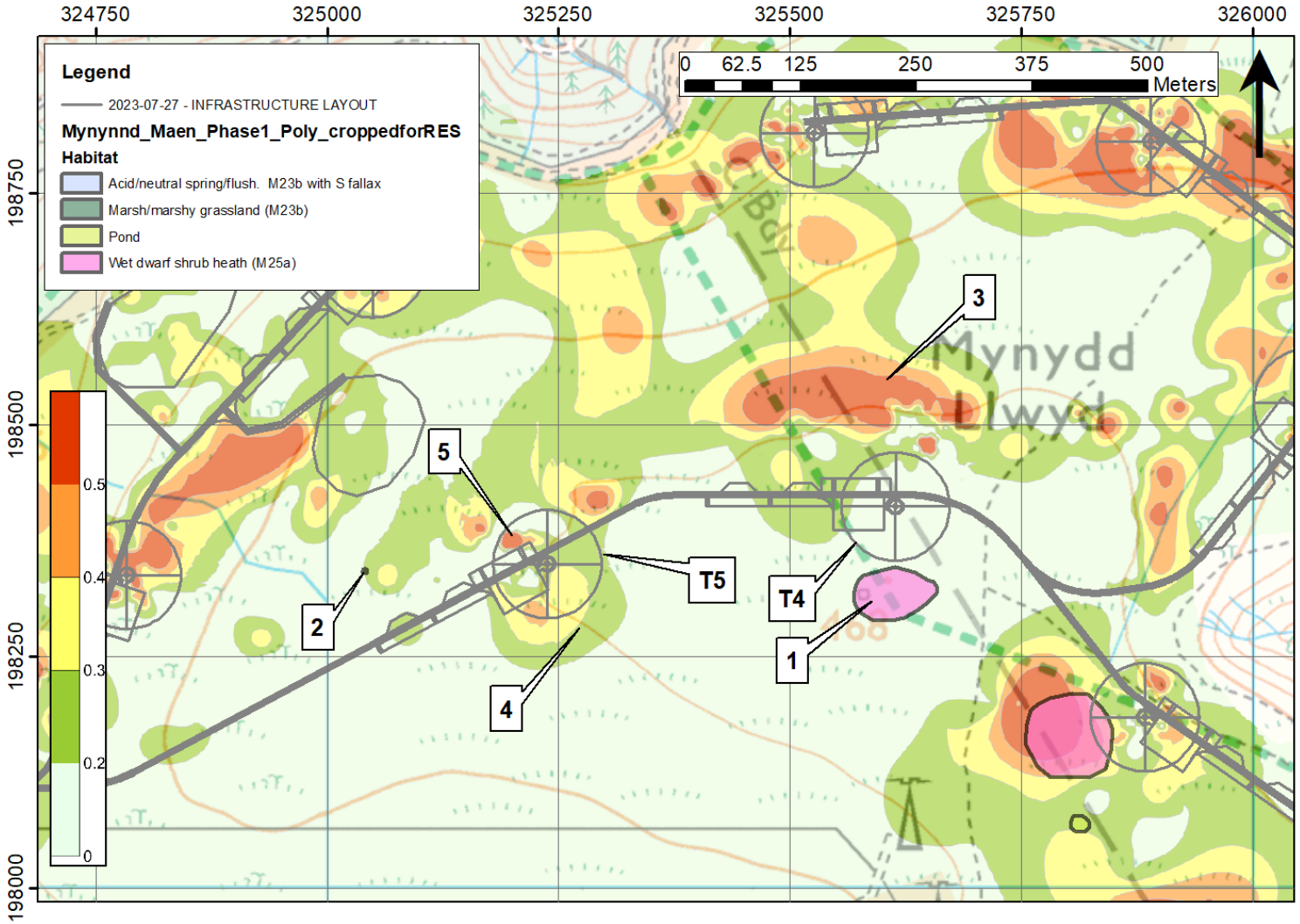

Figure 3. Annotated plan showing peat thickness and occurrence of GWDTEs in the vicinity of proposed Turbines T4-5.

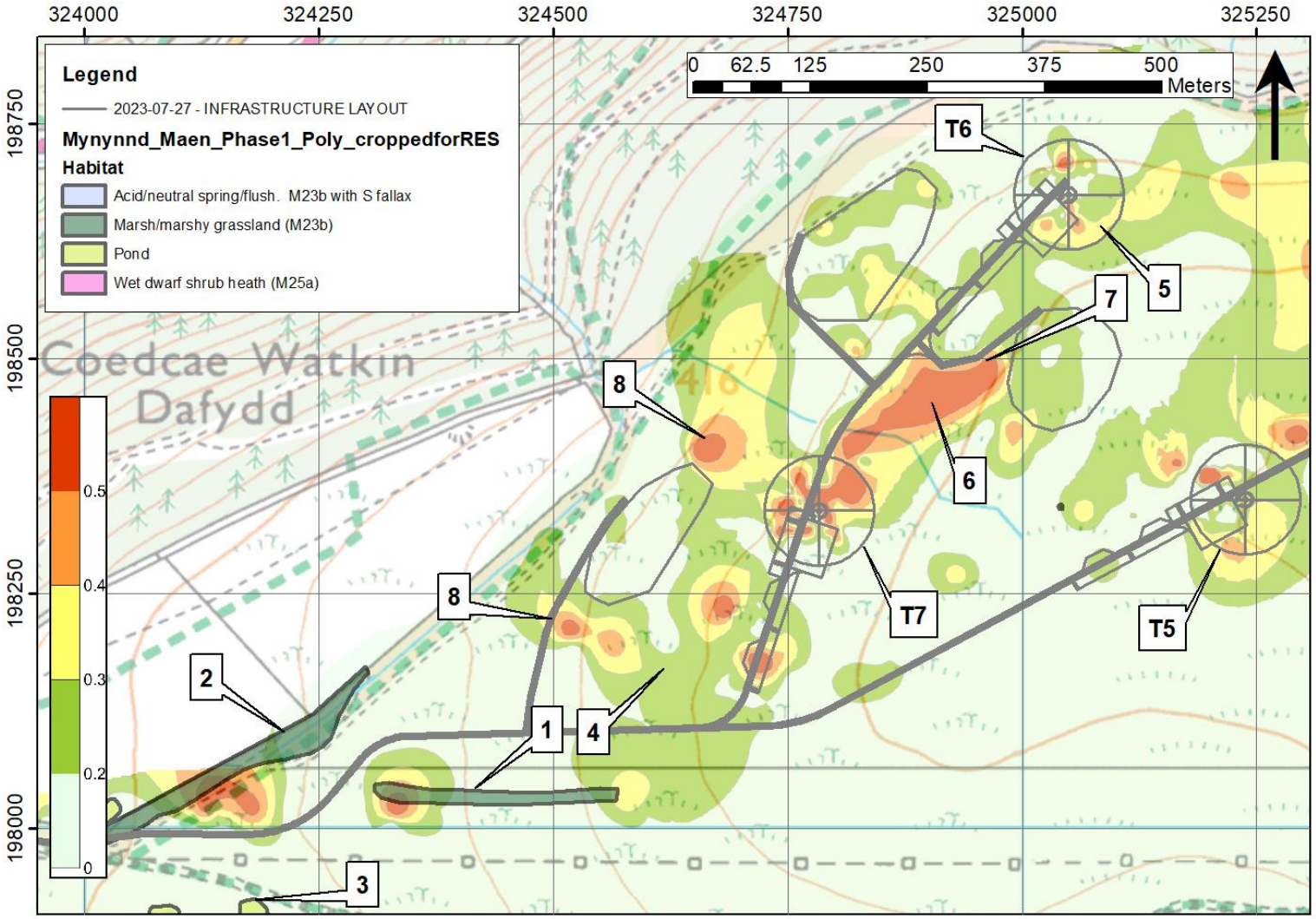

Figure 4. Annotated plan showing peat thickness and occurrence of GWDTEs in the vicinity of proposed Turbines T5-7.

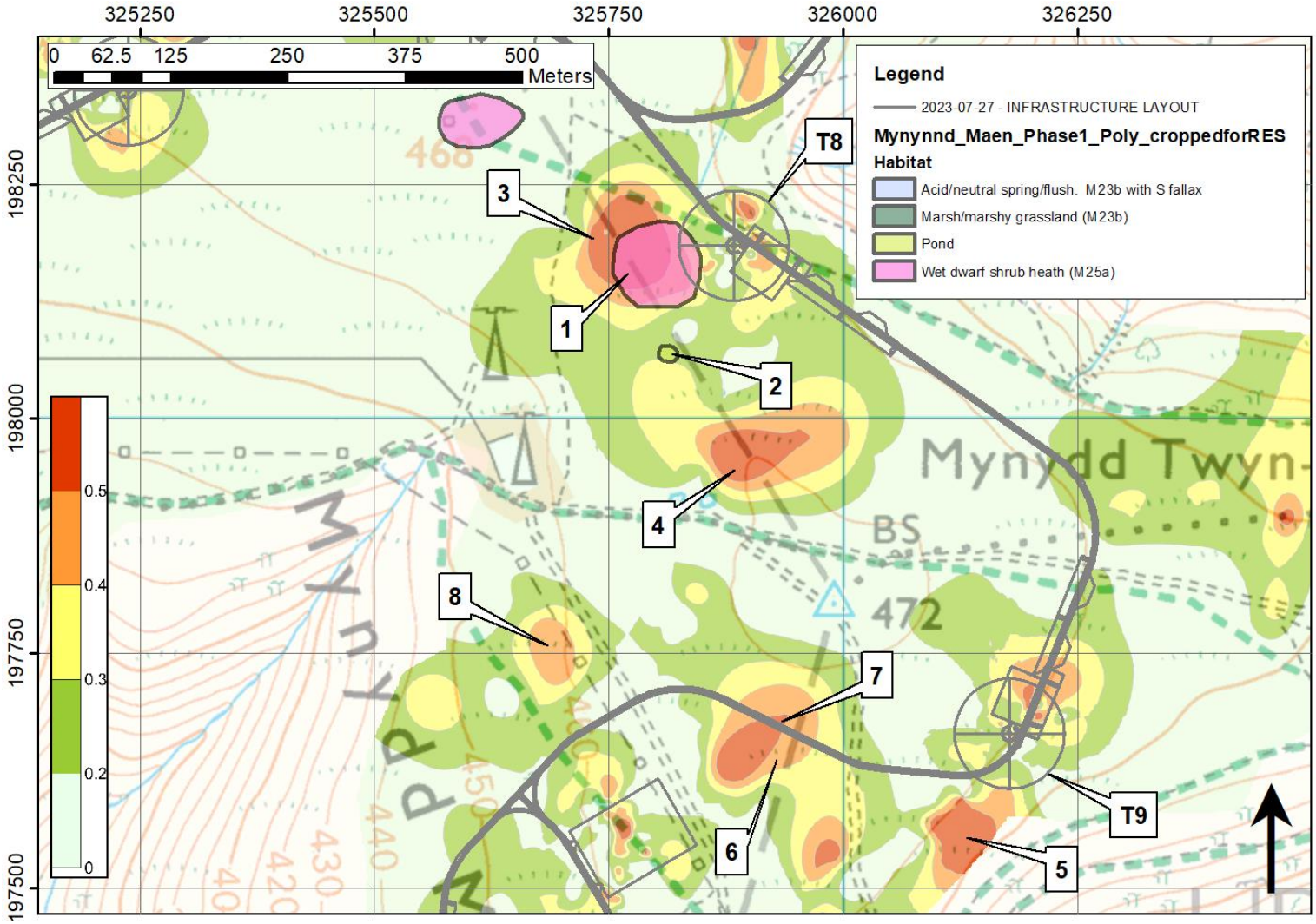

Figure 5. Annotated plan showing peat thickness and occurrence of GWDTEs in the vicinity of proposed Turbines T8-9.

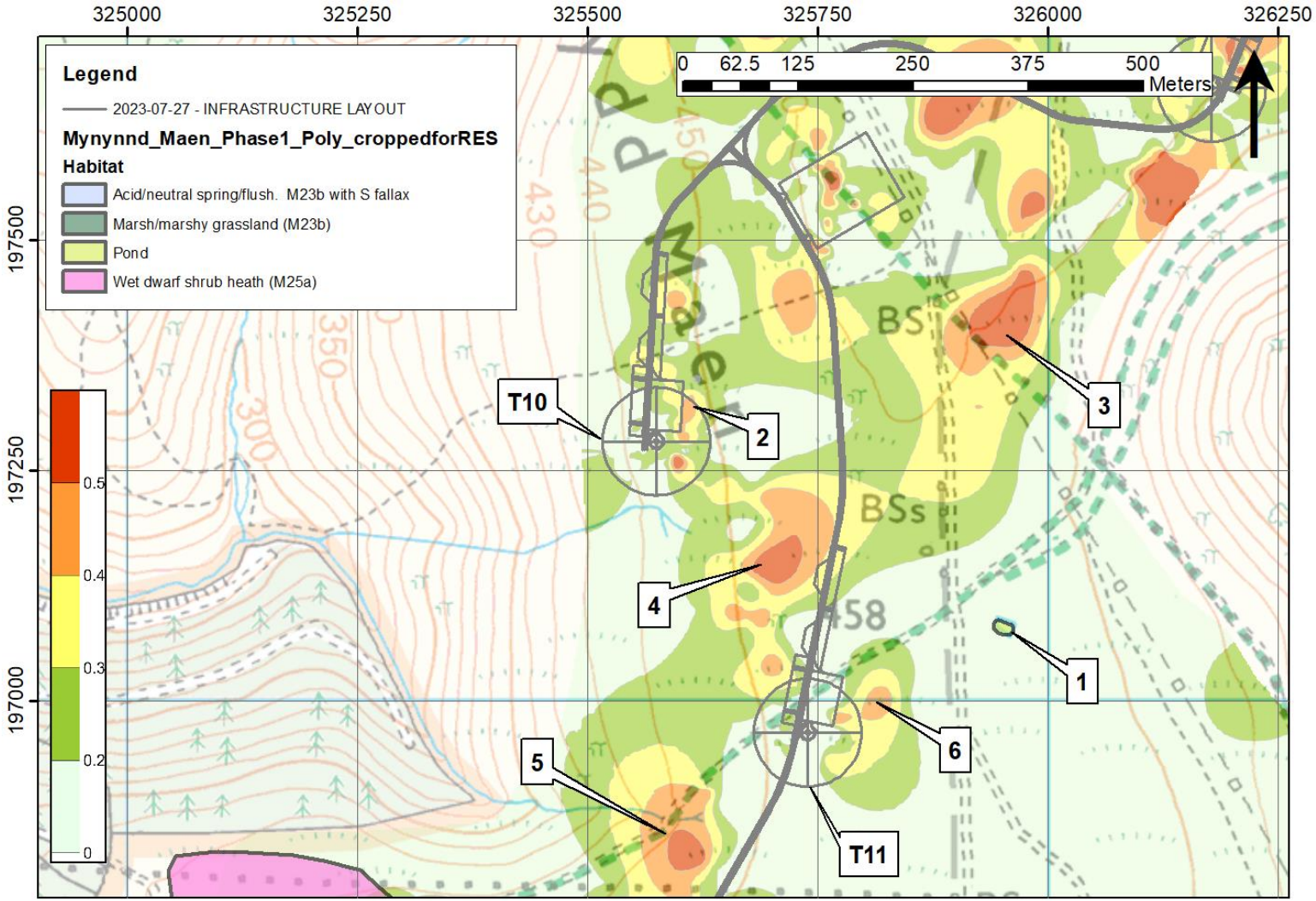

Figure 6. Annotated plan showing peat thickness and occurrence of GWDTEs in the vicinity of proposed Turbines T10-11.

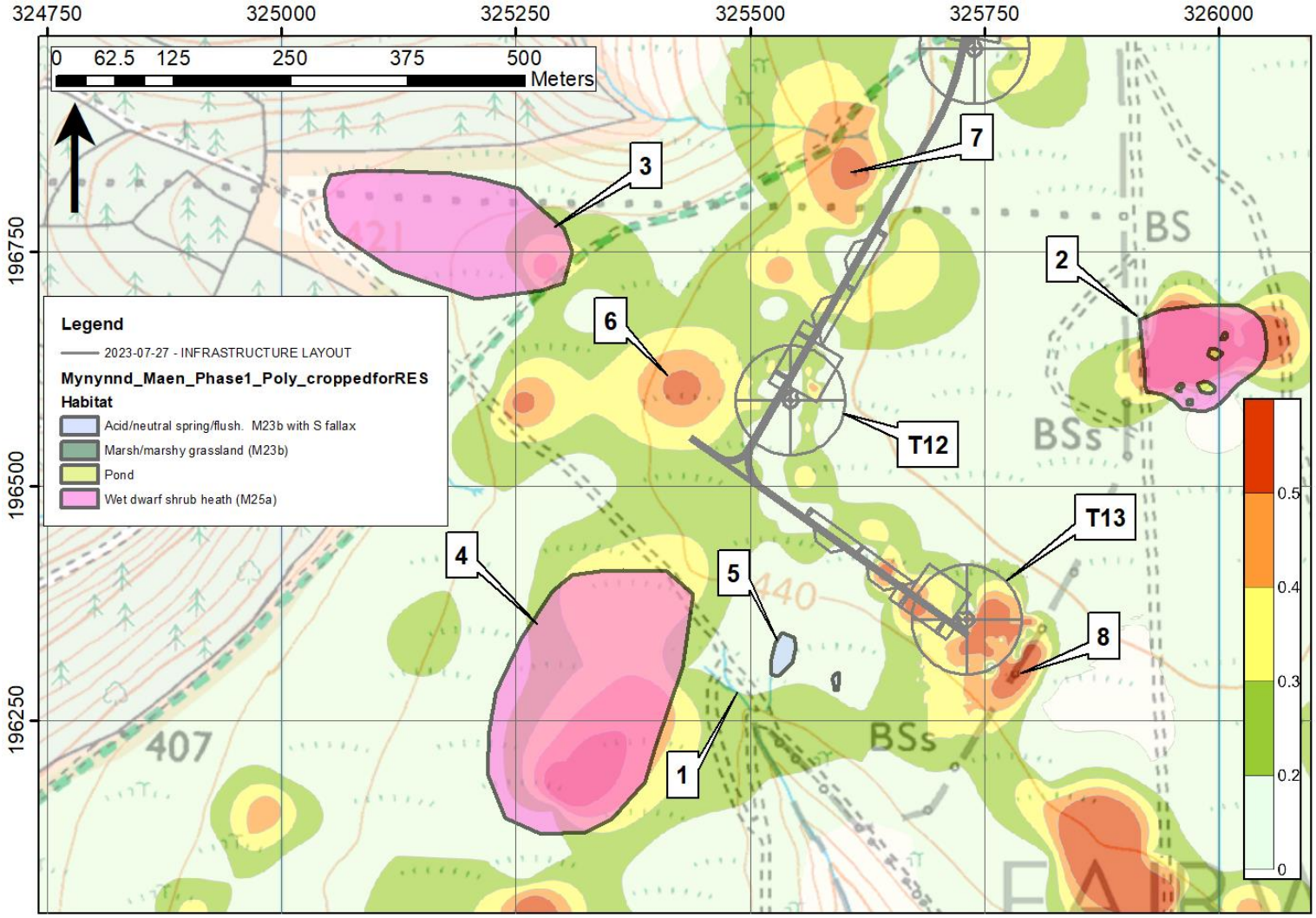

Figure 7. Annotated plan showing peat thickness and occurrence of GWDTEs in the vicinity of proposed Turbines T12-13.