In Confidence

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

A REVIEW OF THE HYDROGEOLOGY ELEMENT OF THE LOCHELBANK WIND FARM ENVIRONMENTAL STATEMENT

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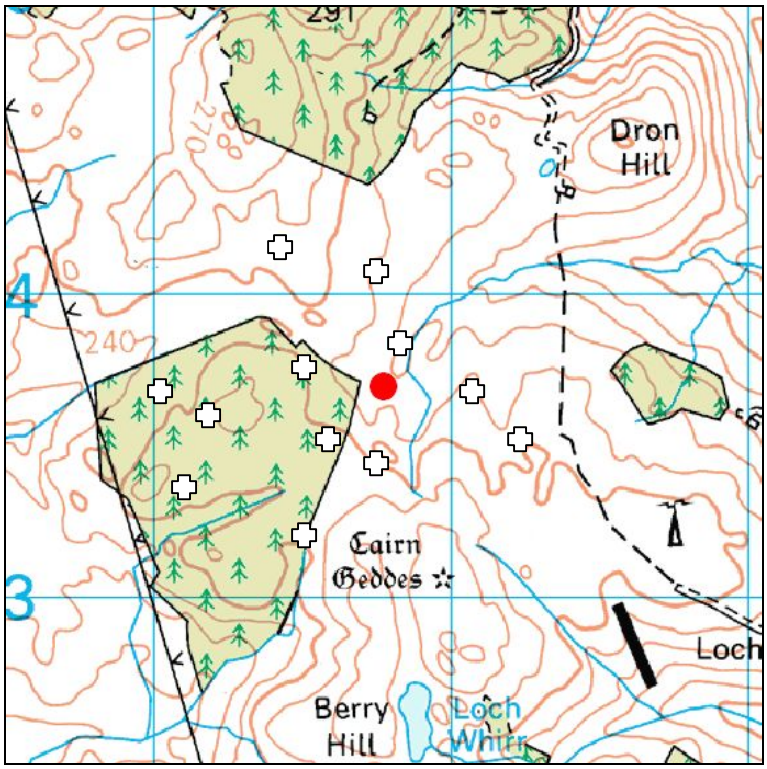
Derek Ball

Section 1

Location of the Mellock Hill site



Scale: 1:25000 (1cm = 250m)

● APPROXIMATE CENTRE OF SITE

✣ Approximate turbine site

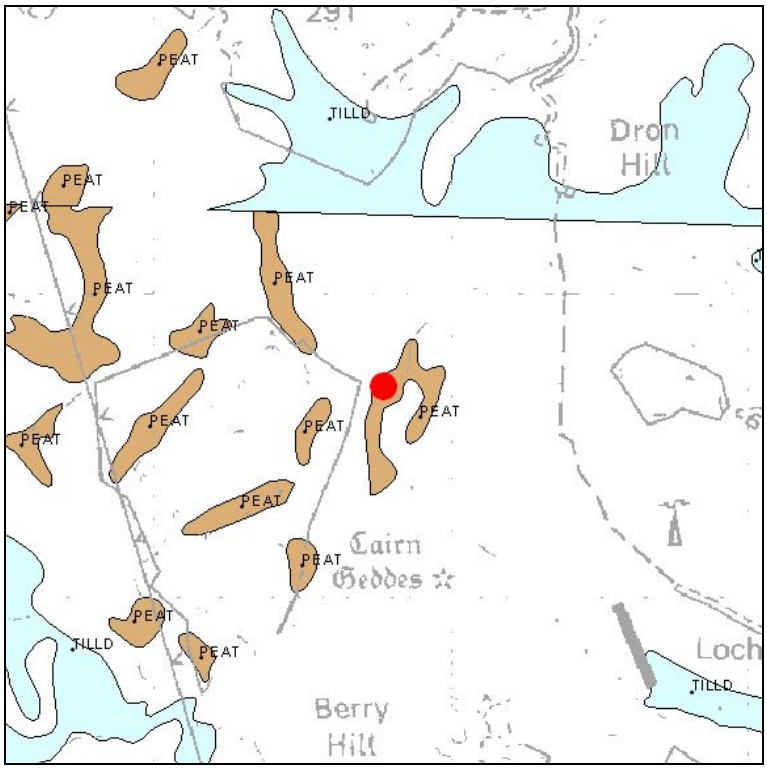
Figure 1: Location of the Mellock Hill site

The site is located approximately 3.5 km north-west of the village of Glenfarg in Perth and Kinross.

Geology

Superficial Deposits

These include glacial deposits, which lie on the bedrock in many areas, and areas of peat.



Scale: 1:25000 (1cm = 250m)

● SITE LOCATION

Key to Superficial deposits:

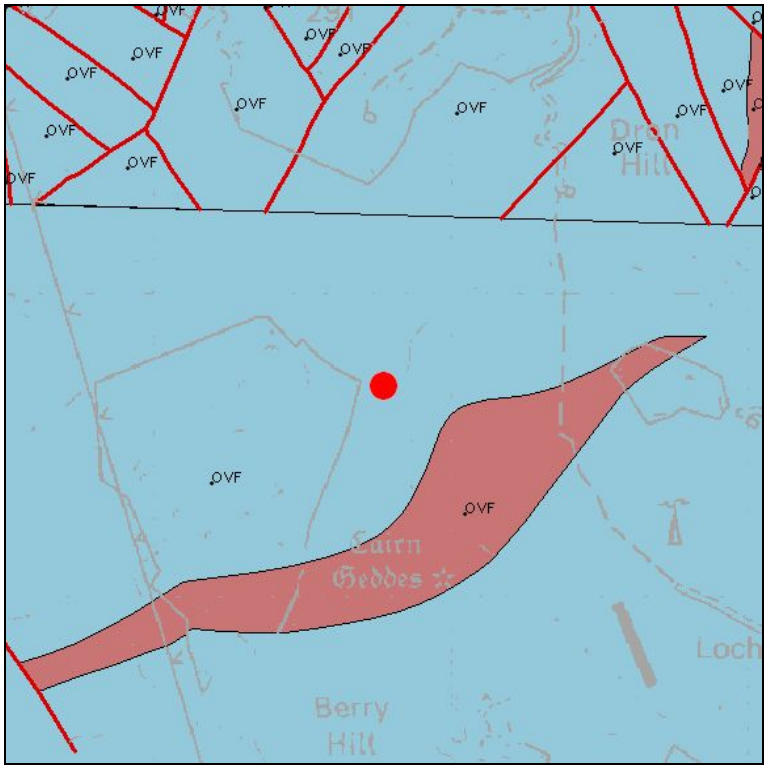
Map colour	Computer Code	Rock name	Rock type
	PEAT	PEAT	PEAT
	TILLD	TILL, DEVENSIAN	DIAMICTON

Figure 2: Superficial deposits

Much of the lower and middle hill slopes are underlain by patchy glacial till (Figure 2) that is expected to thicken at lower elevations. The deposit is a predominantly clayey, stony deposit with occasional coarser grained sand and gravel horizons. The main proposed area for turbine installation is underlain by superficial deposits thought to be less than 2 m in thickness. Bedrock is, therefore, either at or very close to surface.

The straight-line feature seen in the northern part of Figure 2 represents the boundary between BGS Geological Sheet No. 48W, to the north, and Sheet 40W to the south. Clearly, differences in mapping techniques have resulted in the recording of large areas of till to the north whereas to the south, across much of the project area, no deposits are mapped. It can be assumed, however, that till forms a more extensive deposit than indicated on the map for the project area, but the details are currently unknown.

Bedrock



Scale: 1:25000 (1cm = 250m)

SITE LOCATION

Fault

Coal, ironstone or other mineral vein

Note: Faults and Coals, ironstone & mineral veins are shown for illustration and to aid interpretation of the map. Not all such features are shown and their absence on the map face does not necessarily mean that none are present

Key to Bedrock geology:

Map colour	Computer Code	Rock name	Rock type
	OVF	OCHIL VOLCANIC FORMATION	BASALTIC ANDESITE
	OVF	OCHIL VOLCANIC FORMATION	PYROXENE-ANDESITE
	OVF	OCHIL VOLCANIC FORMATION	CONGLOMERATE

Figure 3: Bedrock geology

Lower Devonian basalt-andesite rocks of the Ochil Volcanic Formation underlie the whole site (Figure 3). The volcanic rocks are fine-grained and fractured, the upper few metres of which at rockhead are normally highly fractured as a result of glacial activity and weathering processes. They originally formed as layers of lava outpouring from volcanic centres. Over time, they have been broken into faulted blocks, as mapped in the northern part of the area. The southern zone is likely to be similarly faulted, but newer mapping techniques have yet to be applied to this BGS geological sheet which, however, accurately indicates the whole area to be underlain by volcanic rocks.

A layer of volcanic conglomerate has been mapped in the centre of the area. The layer was formed by erosion of rock beds by rain and rivers with deposition by mudslides and streams. It comprises fragments of volcanic rocks set in a fine-grained matrix. The nature of deposition means that the conglomerates are discontinuous in nature and can vary greatly in thickness over a short distance. The composition of the conglomerate differs from the basalt and it may be liable to greater weathering effects, resulting in a more permeable rock body at shallow depths.

Hydrogeology

Superficial deposits

BGS holds no detailed data on the hydrogeology of the Lochelbank project area.

Shallow groundwater may be present in relatively small quantities within any locally permeable beds within the thin till deposits that drape the valley sides. Water-bearing deposits such as these may be the source of the at least some of the minor springs in the area. In places, these springs can form useful, but vulnerable, domestic supplies, although we have no information as to which springs in the area are derived from superficial deposits nor which have the potential for exploitation. Groundwater also occurs in areas of peat and mire which can, in places, be dependent on groundwater for the continued existence of local ecological environments.

Bedrock

The upper, weathered, zone of the Ochil Volcanic Formation is the principal layer where groundwater is present. Rainwater infiltrates from the surface to enter the relatively permeable thin fractured zone which lies above fresh rock. Water can also enter and move along deeper fractures and fault lines that may be present. Groundwater from this source can contribute to springs where fault lines and fractures are intersected at the surface.

Section 2: The Environmental Statement review

The revised Environmental Statement (ES) has been produced by ERM and is dated April 2005. The sections referring to groundwater and private water supplies appear in the main body of the document in Sections 4.3 and 4.4. Private water supplies are dealt with by Dalgleish Associates in Annex J

The proposal is for the construction of up to 12 turbines, 3.5 km north-west of Glenfarg village.

Section 4.3: Geology and Hydrogeology

Geology

Both sections provide a general description of the till as being the predominant superficial deposits in the area. Neither description attempts to describe the distribution or thickness of the deposits in any detail. Section 4.3.2 refers to patchy peat, which has been mapped across parts of the project area. Annex J does not mention the peat deposits, but refers to localised deposits of alluvium as being present. However, the latter do not appear on the BGS map anywhere in the project area, the nearest occurrence being near Glenfarg village.

Both sections provide a very brief description of the bedrock, with no detail included as to the nature of the different rock units. In both sections, the presence of fractures in bedrock is mentioned only in paragraphs dealing with groundwater flow. The Dalgleish Associates report combines geology and hydrogeology in the one section.

Both sections require further detail as to the nature and distribution of the superficial deposits, particularly as the southern BGS geological sheet is lacking in detail compared to the northern one.

Hydrogeology

Section 4.3.2 and Annex J (Section 2.2) provide descriptions of the hydrogeological conditions across the site. Recognition of the relatively small amount of groundwater held in storage in the till and bedrock is made and that groundwater may occur where the rock is fractured or weathered.

Both descriptions are correct in their basic assumptions that nowhere within or around the project area is groundwater present in very large volumes. Section 4.3.2. correctly recognises the role of shallow groundwater in the area in maintaining flow to minor watercourses and groundwater-dependent areas of vegetation, although no specific details are provided.

Annex J incorrectly dismisses the till as being of low permeability and by inferring that it is not a source of groundwater. Somewhat confusingly, this section refers to

alluvial deposits as being 'perched' aquifers, but nowhere in the or around the project area is alluvium mapped.

Groundwater vulnerability

Groundwater vulnerability is mentioned in Section 4.3.2. para. 8 and in Annex J para. 1. Both incorrectly assume that the till is impermeable and, by inference, forms a largely effective barrier to surface pollutants from entering the groundwater system. These assumptions are wrong on two counts: firstly, the coverage of the till layer is largely unknown across the project area and may be absent in places. Secondly, the till cannot be assumed to be impermeable because it may have a stone content sufficient to allow liquids to pass relatively easily through it. It is also unlikely to be thick enough across the area to have much effect on retardation of contaminants during the vertical transport of liquids underground.

Both sections assume that groundwater vulnerability is low. This is not correct. The latest thinking by BGS and SEPA is that groundwater under upland hard rock areas where thin superficial cover is present, as at Lochelbank, is highly vulnerable to contamination from the surface. This is because there will be little scope for attenuation of pollutants to take place in the unsaturated zone within fractured rock compared to an intergranular-flow medium such as sand where there is greater potential for adsorption and filtration to occur.

Receptors

Private water supplies:

Both Section 4.3.2 and Annex J provide the same Table that list 13 private supplies within the study area. The map provided, by Dalgelish Associates, of the spring locations should be clearer and indexed to the Table of sources.

BGS do not hold accurate records of all the springs in the area and cannot comment on the comprehensiveness of this list. Comments by the Wind Farms Awareness Group on the list include mention of additional supply sources at Fordel Hill, Heatheryleys and Rossie Farm. However, there are no significant supply sources either within or adjacent to the project area.

BGS consider that the spring at Lochelbank Farm is highly likely to be affected by any construction activities associated with the wind farm owing to the close proximity of the construction compound and main operations building.

It is important to determine the location and nature of all private water supplies in the area. Further work to confirm the above additional supplies should be carried out.

Other springs

Most of the proposed sites for turbines are close to springs and 'collects' as marked on the OS map. Temporary disruption or contamination of these sources is possible

during construction. It is important that these water sources are investigated to determine their nature and their existence be recognised on a map with turbine locations and access tracks etc. added.

Impacts on the water regime

Impacts to both surface water and groundwater are listed in Sections 3.1 and 3.2. The latter does not list changes to turbidity or other water quality parameters as being potential impacts, although these are discussed later in the section on site water management.

Groundwater-dependent ecosystems

The Pitkeathly Mires SAC is mentioned as being located close to the western boundary of the project area. The surface water catchment of the mire has been outlined in Figure 4.2. No attempt has been made to recognise whether the groundwater catchment for the mire is significantly different to the surface water drainage boundary. BGS has not carried out any detailed study of the potential impact on the mire of the turbine construction, but any significant alteration to the water flow into the mire is thought to be unlikely. In spite of the close proximity of Turbines 1 and 4 to the mire, their surface elevations are, at approximately 245 m and 255 m OD respectively, lower than the catchment divide that borders the mire, with much of the mire itself higher than these elevations. Groundwater can move through bedrock fractures independently of surface topography, but, in this case, little threat to the mire is likely, as the turbines are located within separate groundwater discharge areas, providing baseflow to streams flowing south-west of the mire or east of it.

Impacts

Both reports conclude that the threat to all spring sources and Pitkeathly Mire is insignificant. Whilst the BGS agree that most of the supply sources are well away from any disruption, the Lochelbank spring is highly vulnerable, as are the unexploited springs within the project area.

BGS considers that Pitkeathly Mire is, on the basis of a limited desk assessment, is unlikely to be affected, provided sufficient mitigation measures are in place. However, see ‘Monitoring’ below, as it is not certain beyond any doubt that changes to the mire could take place.

Monitoring

There appears to be no mention of any groundwater monitoring programme in the reports. It will be important to devise a rigorous monitoring programme for the springs and Pitkeathly Mire in order to detect any alterations to the groundwater regime before damage to the environment is too great to be easily repaired.

Conclusions

- The ERM report is incorrect to state that groundwater under the site is not vulnerable.
- Whilst most spring supplies are unlikely to be affected by any development, the Lochelbank spring is thought to be vulnerable.
- Pitkeathly Mire is unlikely to be affected by the proposed development, although a rigorous monitoring programme should be in place prior to any construction activities, as it is not absolutely certain that a negative effect to the groundwater regime will not occur.
- The ERM assessment should include a detailed programme of monitoring of groundwater prior to any turbine or road construction. This should involve flow and water quality monitoring at spring sources and other features associated with Pitkeathly Mire.