In Confidence

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

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

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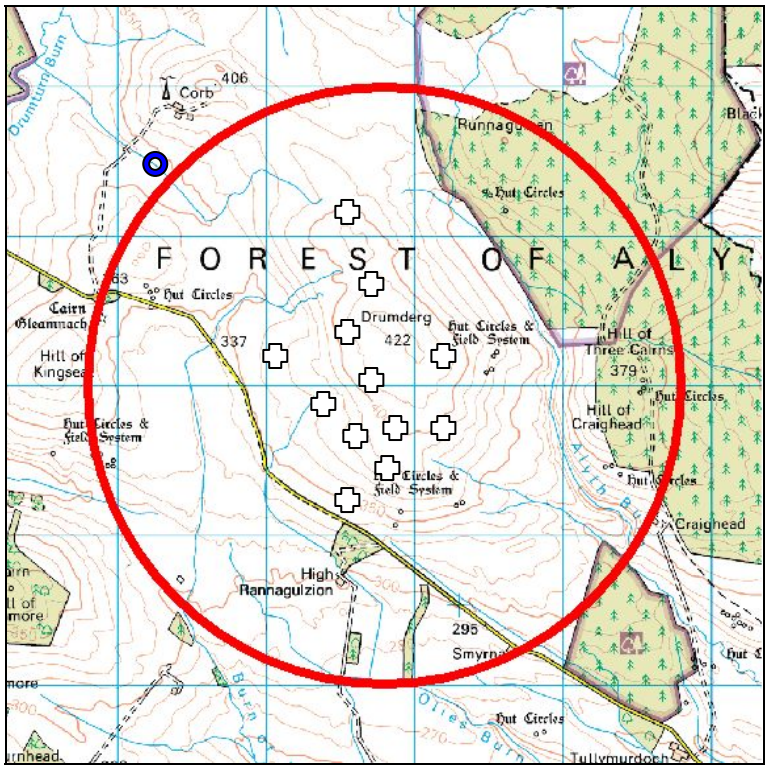
Section 1

Location of the Drumderg site



Scale: 1:50000 (1cm = 500m)

Approximate area of turbines

Corb water source

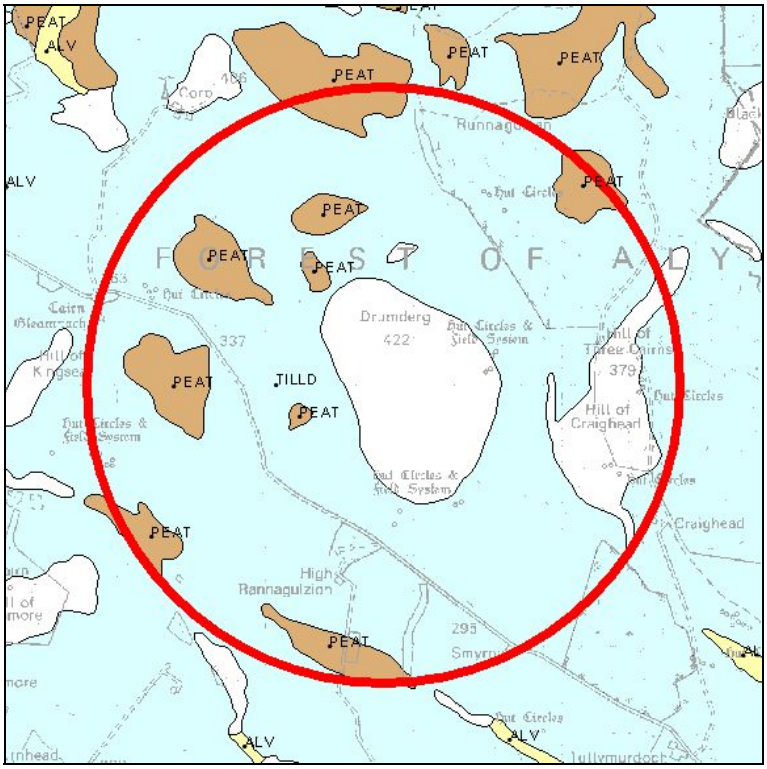
Figure 1: Location of Drumderg

1 Geology

Superficial Deposits

Much of the hillside is underlain by thin, patchy glacial till (Figure 1). This is a predominantly sandy, stony deposit, varying in thickness from less than 1 m to more than 8 m locally. The main proposed area for turbine installation is underlain by very thin superficial deposits, and bedrock is either at or very close to surface.

Peat deposits are not extensive, and occur in patches, particularly in the north-western part of the area.



Scale: 1:50000 (1cm = 500m)

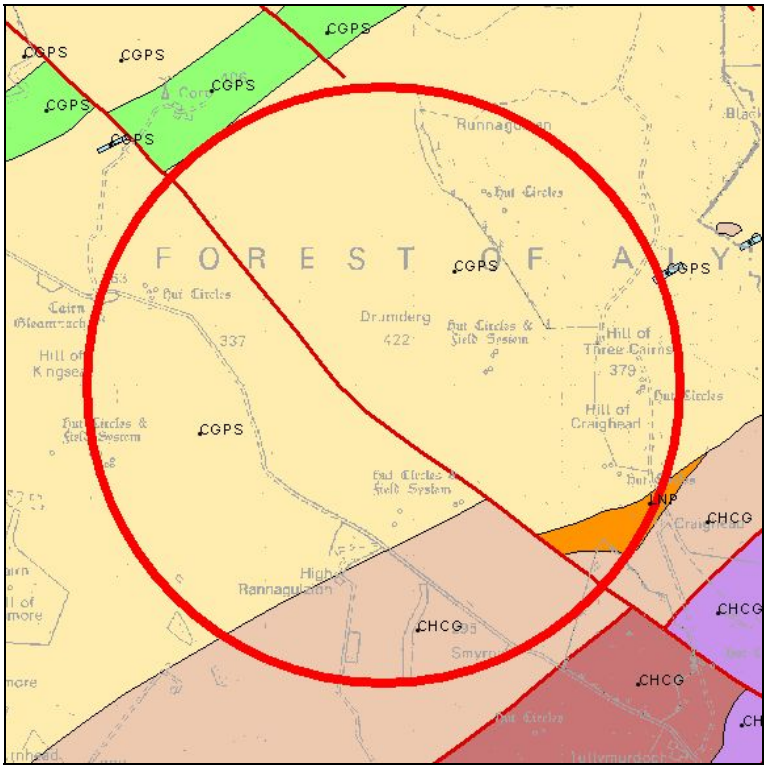
Key to Superficial deposits:

Map colour	Computer Code	Rock name	Rock type
	ALV	ALLUVIUM	GRAVEL, SAND, SILT AND CLAY
	PEAT	PEAT	PEAT
	TILLD	TILL, DEVENSIAN	DIAMICTON

Figure 2: Superficial deposits

Bedrock

Precambrian metamorphic rocks underlie the whole site (Figure 2), with Lower Devonian conglomerate present immediately to the south (400 m south of Turbines 1 and 5). The Precambrian rocks belong to the Southern Highland Group and comprise rocks of the Cairn Gibbs Psammite Formation. These are hard, fractured rocks that have been subjected to heat and pressure to form complex structures. The general dip of the rock strata is to the south-east, but this varies greatly locally. The psammite is faulted in many places. The upper few metres of the rock are normally highly fractured as a result of glacial activity and weathering processes.



Scale: 1:50000 (1cm = 500m)

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
	CHCG	CRAIGHALL CONGLOMERATE FORMATION	BASALTIC ANDESITE
	CHCG	CRAIGHALL CONGLOMERATE FORMATION	ANDESITE
	CHCG	CRAIGHALL CONGLOMERATE FORMATION	CONGLOMERATE
	LNP	LINTRATHEN TUFF MEMBER	TUFF
	CGPS	CAIRN GIBBS PSAMMITE FORMATION	METAMORPHOSED LAVA AND TUFF
	CGPS	CAIRN GIBBS PSAMMITE FORMATION	PELITE
	CGPS	CAIRN GIBBS PSAMMITE FORMATION	PSAMMITE

Figure 3: Bedrock geology

2 Hydrogeology

Superficial deposits

Groundwater is present mainly within sandy, gravelly beds interbedded with till deposits. These are common in the area, particularly on the lower slopes of the valleys where significant flows of groundwater are present. These can form useful, but vulnerable, domestic supplies. However, the main body of till itself can also have a significant permeability owing to the sandy nature of the material and the presence of fracturing. The groundwater flow paths in till are very localised and can be complex. They are dominated by the presence of higher-permeability beds of sand and gravel which may occur sporadically. We have no data on the hydrogeology of the project area.

Areas of peat and raised mire can, in places, be supplied with groundwater from springs emanating in upland tills. The exact source of water for the mires at Drumderg is not known in detail.

Bedrock

The upper weathered zone of the psammite is the principal layer where groundwater is present. Here water infiltrates from the surface in addition to the basal beds of the till and peat, to enter the relatively high-permeability fractured zone. From here, groundwater moves down slope to appear at springs. Many shallow wells are dug into this layer to intercept the water table.

Section 2: The Environmental Statement review

The ES has been produced by Enviros and is dated October 2003.

The proposal is for the construction of 16 turbines on Drumderg (NO 178 550), near Bridge of Cally.

Chapter 12: Geology, Hydrogeology and Hydrology

(Numbers refer to the Chapter Sections)

Potential effects on the water environment

The potential effects on the water environment are adequately covered in 12.5 and Table 12.1.

Geology

12.29 to 12.31 cover the geological description adequately. BGS maps for the area have been used in the description. There is some detail concerning field observations of gravelly horizons in the till.

Overall, an accurate, basic summary, although mention should be made of the adjacent Lower Devonian rocks.

Hydrogeology

12.32 refers to the BGS hydrogeological map of Scotland. Recognition of the relatively low amount of groundwater held in storage is made, but the statement 'generally without groundwater' is not entirely true for the psammite bedrock. Many boreholes provide water supplies in other parts of Scotland from similar rocks. Abstraction of groundwater can be made from water-bearing fractures over 60 m below surface.

No mention is made of the potentially significant shallow groundwater present in the sandy and gravelly till deposits. This could be important when considering the potential impact on private water supplies.

Groundwater vulnerability

SEPA's latest vulnerability maps, produced by BGS, indicate that fractured bedrock with thin or no sandy till cover is highly vulnerable to pollution. However, these maps are not available to consultants yet. Therefore, Enviros has, correctly, used the latest publicly accessible data sources.

Receptors

Private water supplies: 12.34 mentions the Corb spring (Figure 1) as the only private groundwater supply identified. The well is described as a collection sump from a spring located further up on the hillside, although no exact location is given for the true source of water, the spring.

12.70 concludes that the Corb spring supply will be unaffected by construction activities and, therefore, at low risk.

BGS concludes that the actual location of the water piped to the well needs to be investigated before a decision can be made on risk. Turbines 12, 13 and 14 are the closest to the source and, although are unlikely to affect it, the location should be determined, in spite of the low risk. The effects of the operational phase on groundwater is expected to be insignificant.

Surface water: 12.40 lists surface water supplies from local streams. These are important sources of water as they supply over 12 properties. Mention is made of the land owner who has informed Enviros that the burn flowing near Rannagulzion Farm flows for most of the time and supplies 10 properties. This infers a shallow groundwater source for the water, possibly from permeable beds in the till or weathered bedrock.

The source of the water providing baseflow to this stream needs to be investigated, as Turbine 3 and the borrow pit may be located in the catchment area for the stream.

In particular, the borrow pits (12.64) (locations in the subsequent clarifications) near Turbines 2 and 3 may affect baseflow to this stream.

12.71 and 12.72 refer to surface water abstractions and the potential impacts of construction on them. These are said to be insignificant to minor.

BGS considers that groundwater baseflow to the streams may be significant. Therefore, the construction of tracks and pits some distance from the burns may have a temporary effect on the quality of water in them. This is unlikely to be significant, but the report should recognise the role of shallow groundwater flow in bedrock and drift deposits as baseflow to surface streams.

Operational phase activities are considered by BGS to be insignificant.

12.45 states that deeper groundwater is not a significant receptor. This may not be entirely true, owing to the relatively permeable nature of the weathered bedrock zone, which provides recharge to deeper fractures in the psammite.

Recognition should be given to the presence of deeper groundwater, although it is unlikely that any deep abstraction boreholes located more than 2 km from the margins of the development area would be affected.

Groundwater-dependent ecosystems

12.73 refers to the SSSIs and the likely impact of construction activities. Enviros consider the impact to be insignificant.

BGS consider that there may be a minor, localised, impact on parts of the cSAC close to Turbines 4, 8, 11, 12, 13 and 14 during construction only, but there is a low probability of this.

Monitoring

The report provides a plan for monitoring both pre-, during and post- construction. This is entirely adequate for surface waters, but should also include the spring supply at Corb.

Conclusions

- Shallow groundwater in the sandy till and weathered bedrock zone may be providing significant amounts of groundwater as baseflow to streams and the spring near Corb.
- Whilst BGS consider the overall risk to groundwater receptors as low, there may be local impacts on shallow groundwater with temporary reductions in water quality.
- Consideration needs to be given to including the Corb spring in the monitoring network.