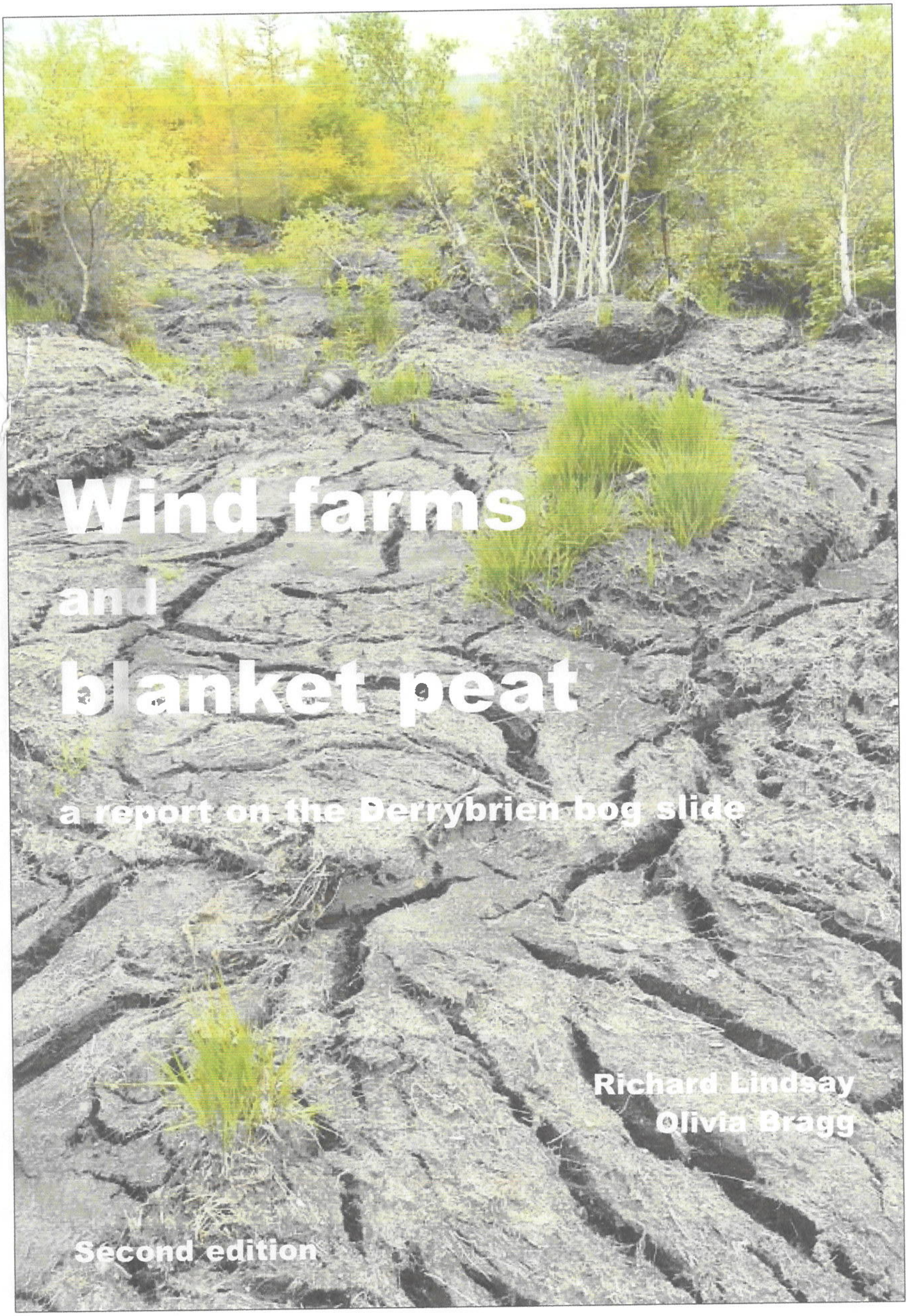
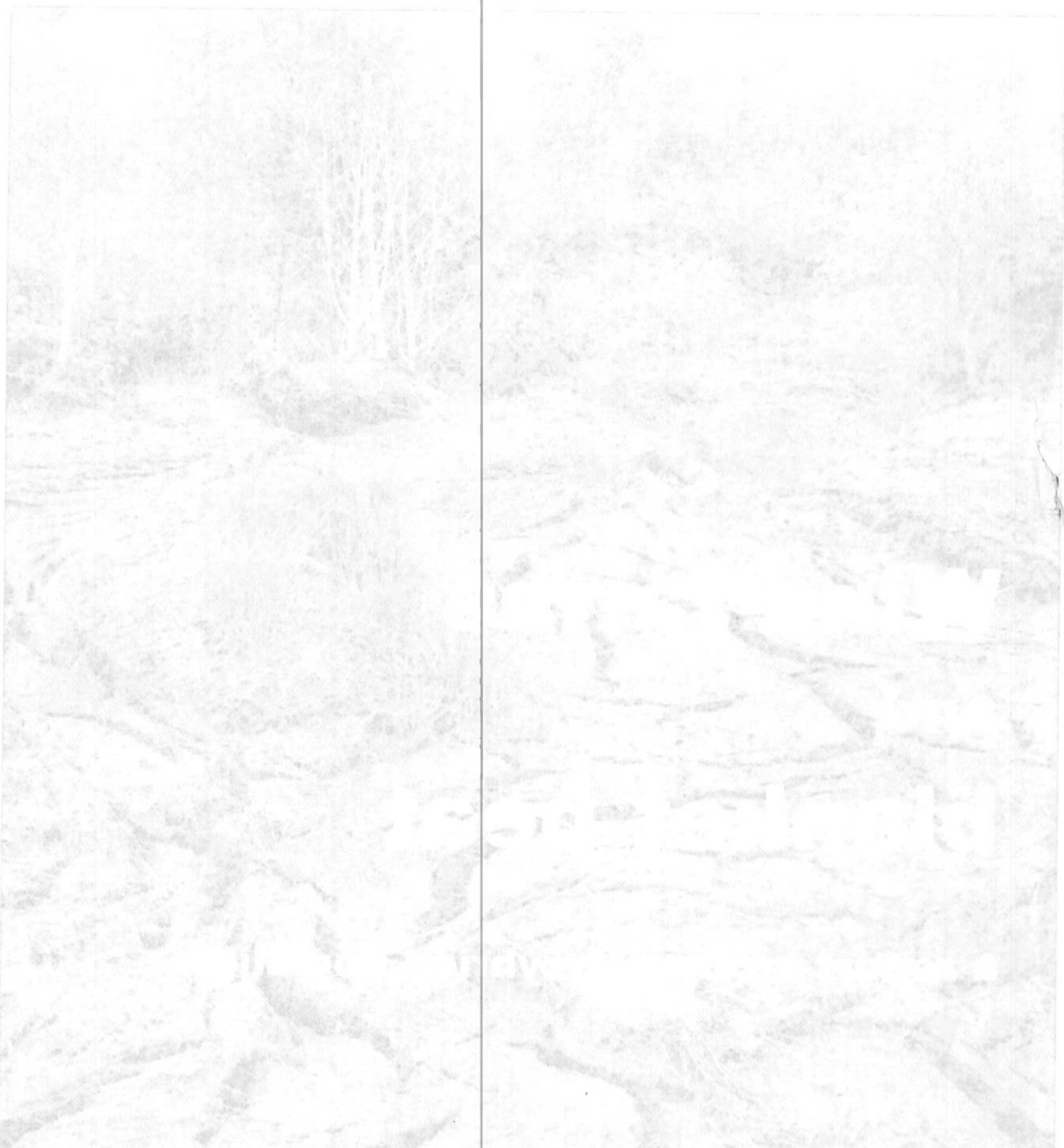


Wind farms and blanket peat

a report on the Derrybrien bog slide

Richard Lindsay
Olivia Bragg

Second edition



WIND FARMS AND BLANKET PEAT

The Bog Slide of 16th October 2003 at Derrybrien, Co. Galway, Ireland

Richard Lindsay
Olivia Bragg

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November 2005

This is the second edition of a report first published in October 2004. While the opportunity was taken to correct minor errors of fact or attribution brought to the attention of the authors since publication of the first edition and slightly to edit the text for style, it is essentially unchanged.

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He was appointed National Peatland Specialist to the NCC's Chief Scientist Team in 1981 and remained in that post until transferring to Scottish Natural Heritage on the creation of the successor statutory agencies to the NCC. During this time he was involved in a number of high-profile conservation cases including the effect of forestry in the Flow Country of northern Scotland, the issue of peat-use in horticulture and with implementation of the EU Habitats Directive. In 1996 he spent 17 months undertaking international peatland conservation work in Australia, New Zealand, China, Japan, Latvia, France, Austria and Russia, before joining the University of East London in late 1997.

For 16 years he was Chairman of the International Mire Conservation Group (IMCG), which is the international network of peatland specialists who advise their respective governments about peatland conservation issues. He continues to be the IMCG's representative on the European Habitats Forum. He has written and broadcast extensively about peatland conservation issues both in the UK and abroad.

Olivia Bragg is a Visiting Research Fellow at both the University of East London and Cranfield University and is a Research Fellow at the University of Dundee. After graduating from Cambridge University with BA and MA and obtaining her PhD from the University of Dundee, she worked on a wide variety of topics within the general field of eco-hydrology, specialising particularly in peatlands.

She has undertaken a very large body of work examining the eco-hydrological condition of particular peatland sites throughout Britain, has worked on several sites in Russia and Indonesia and others in Canada, Ukraine and Belarus. She was responsible for a major Darwin Initiative programme involving knowledge-transfer of peatland conservation management skills through a number of Central European countries and was co-editor (with Richard Lindsay) of a Strategy for Peatland Conservation in Central Europe.

She has also heavily involved, through the University of Dundee, in development of the EU Water Framework Directive in Scotland and has been responsible for devising a range of key protocols in this work. She is also a Board Member of the International Mire Conservation Group and has recently been appointed Editor of the International Peat Journal.

Acknowledgements

The authors would like to record their gratitude to a number of people and organisations who assisted in producing this report. Several very kindly provided us with information about bog slides and bog bursts from around the world: Mrs Elizabeth Feldmayer-Christie, WSL Zürich, sent valuable papers about the bog burst at La Vraconnaz in Switzerland; Dr Mette Risager sent intriguing aerial photogaphs of a possible bog burst in Denmark and Dr Andy Douse, Conservation Strategy Officer, Falkland Islands, kindly hunted out a range of information on bog bursts in the Falklands.

Dr Russell Anderson, Northern Forest Research Station, UK Forestry Commission, was most helpful when we were drawing together the literature concerning the effects of plantations on peat and generously allowed the use of some particularly relevant images. The staff of Hibernian Wind Power Ltd were particularly courteous and helpful in showing us round the Derrybrien site, providing both transport and information about the wind farm process.

We are grateful to the Ordnance Survey of Ireland for permission to use a range of digital information in the production of this report. Its staff were generous with their time in providing the maps and data that enabled us to carry out a useful spatial analysis of the site.

Valuable information about the site, the general environment of the area or wind farms in other parts of Ireland or the UK was provided by Dúchas, English Nature, Scottish Natural Heritage and the Countryside Council for Wales.

Useful comments on drafts of the report were offered by Dr Anderson, Mr Martin Collins, Dr Trevor Orr and Mr Dan Shields. Martin Collins also provided an prodigous amount of background information, including useful photographs of the Derrybrien site and of the bog slide at Sonnagh Old. He also undertook the organisation of our site visit.

Finally, we are grateful to the University of East London for providing the time and resources for us to carry out the work.

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PART 2 – EVENTS OF 16 OCTOBER AND SUBSEQUENT ISSUES

WIND FARMS AND BLANKET PEAT

The Bog Slide of 16th October 2003 at Derrybrien, Co. Galway, Ireland

R.A. Lindsay and O.M. Bragg
University of East London, 2004

EXECUTIVE SUMMARY

Introduction

THE DERRYBRIEN BOG SLIDE of October 2003 occurred during construction of a 71-turbine wind farm. As well as examining some wider issues, this report examines key areas of the project, the bog slide event and issues arising from it, including :

- the nature of the area within the windfarm site; the likely environmental impact; the planning process; events leading up to, and possibly causing, the slide; an assessment of the geotechnical reports and some future scenarios.

Nature of the development area

Recommended procedures for Environmental Impact Assessment (EIA) involve an initial scoping stage in which the characteristics of a site are established and the area likely to be affected is determined. This is usually an iterative process because many issues have wider effects, e.g. local erosion leads to sedimentation at a distance from the site.

The Derrybrien development straddles the summit of Cashlaundrumlahan, an area dominated by extensive blanket mire generally over 1.5 metres thick and, in many places, over five metres thick. This raises significant engineering problems because peat is a matrix typically of two per cent dead plant material and 98 per cent water (by weight). If peat soils are drained, they tend steadily to oxidise and release CO_2 into the atmosphere. If they are de-stabilised by engineering works, they can erode, washing quantities of material into downstream watercourses.

The blanket peat on Cashlaundrumlahan has already been substantially changed by mature forestry. Particularly on deep peat, this causes it to lose water through evapo-transpiration from the tree roots and reduced rainfall because the canopy cuts off much of the rain. Especially where the forest species is lodgepole pine (*Pinus contorta*), as it is at Cashlaundrumlahan, this causes the peat to crack along the lines of the forestry ploughing furrows. These cracks may be over half a metre deep and many metres long. Following canopy closure after 20 to 30 years, they will extend for considerable distances even though they may be hidden by leaf litter and surface roots. The whole area becomes heavily fissured and, in effect, divided into long ribbons of peat running between the ploughing furrows. The blanket peat is altered from a continuous cohesive mass into a discontinuous series of blocks which are no longer cohesive and may be unstable. This was the situation at Derrybrien prior to development.

Stability of blanket peat

There is substantial evidence from all over the world and from as far back as the Middle Ages, both in the literature and from experience, to show that peat bogs, and blanket peat in particular, can undergo catastrophic collapse. Substantial areas of blanket peat can suddenly begin sliding down hillsides, either as a single slab or as a liquified mass. Sometimes the peat travels many kilometres and there has been loss of life. Almost invariably, the incidents can be linked to human disturbance. Various mechanisms have been proposed for bog or peat slides but there is, as yet, no clear understanding of where or how they occur. This should have led to very careful assessment at Derrybrien before engineering work was undertaken.

Likely impact of the wind farm development

The three main elements of wind farm construction are the building of access roads, the excavation of turbine bases and the erection of the towers.

The developers proposed that the access roads be 'floated' on the peat partly because it was so deep and partly to avoid the need for drainage. However, these 'floating' roads cut across the natural drainage lines of the peatland system so that water tends to become ponded on their upslope while downslope areas become drier. Over time, the roads tend to sink below the peat surface, becoming awash and thus unusable. 'Floating road' technology cannot by its nature be sustained for more than short periods in localised areas. On wind farms, however, the roads have to be maintained for the life of the project (including decommissioning) and they need to be drained to remain usable.

This leads to the constant oxidation of the peat forming the ditch walls. Many 'floating' roads or railways now lie several metres below the peat and are themselves now draining the bog.

The development proposals also claim that excavation of turbine bases will not cause drainage of the peat. These excavations require a hole through the peat and underlying glacial deposits to reach competent bedrock. It is stated that they will not be connected to a drainage system and will not cause drainage of the surrounding area either because they will fill with water or because they will be back-filled with material.

The area excavated for a turbine base is suggested as about 10 x 10 metres. In practice, it is much larger, partly because the stable angle of repose for the cut peat faces means that they cannot be vertical. A turbine also requires hard-standing for heavy construction and maintenance vehicles. Most turbines are sited on sloping ground and, even if they are allowed to fill with water, the upslope faces of the excavation will drain. This is true even if they are back-filled because hard-core is much more porous than peat. Normal construction practices for turbine bases involve explicit drainage of the area around the base, partly to ensure that hard-standing does not become waterlogged. It is likely that the blanket peat will undergo significant hydrological disturbance as a result. There are also issues of load-bearing capacity in relation to expected usage and of how this combined impact will interact with the fissured peat beneath the forest plantation.

There are major concerns about impacts because, if the peat should display instability, either as surface erosion or actual collapse, the effects will be felt primarily in downstream streamcourses. Cashlaundrumlahan is a major watershed and the source of river systems leading into important karst or lake systems, some of which are designated as candidate Special Areas for Conservation (cSAC) under EU legislation. There is a danger that sites of significant commercial or nature conservation interest will be adversely affected if development renders the peat cover unstable. This danger persists for the duration of the development and beyond, not just during construction.

The potential for turbines to pose a hazard to important bird populations is also relevant. The Slieve Aughty Mountains have, for example, been identified as supporting important concentrations of hen harrier in Ireland. These have long breeding cycles, relatively low population densities and low absolute numbers. Loss of only one of two individuals can represent a significant impact. Blade strikes are most likely during periods of adverse visibility such as low cloud cover, conditions that regularly prevail around Cashlaundrumlahan.

The planning process for the Derrybrien development

The planning process for Derrybrien comprised three separate applications. The first two were submitted in 1997, prior to S.I. No. 93/1999, which made even modest wind-farm developments subject to statutory EIA. While an EIA was produced on a voluntary basis for the first proposal, there was no explicit assessment, voluntary or otherwise, for the second. The final application (25 turbines) was subject to statutory EIA because it was submitted after S.I. No. 93/1999.

Being put forward in stages (the EU calls it 'salami-slicing') means that the project has been considered piecemeal: it has not been evaluated as a whole, only a third has been subject to statutory EIA and much of one of Europe's largest wind farms has not been subject to direct assessment at all.

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The assessments present a 'best-case' for the development instead of objectively and comprehensively assessing the full scale of potential impacts. Although they recognise that peat is present across most of the site, there is no discussion of the ecology, hydrology or physical stability of peat soils although most of its potential environmental impacts arise as a result of the characteristics of peatland ecosystem.

Detailed analysis is restricted to noise and visual impacts whereas the most important ecological factors (soils, water and drainage patterns) are considered only to the extent of acknowledging that there might be some mineral sediment release but that this would be prevented. Despite a statutory requirement to consider indirect and cumulative impacts and impact interactions, both EIAs state that there would be no significant impacts. Most important, they do not consider peat stability, although they do recognise that the peat has been severely disrupted by forestry. There is no attempt at stability analysis, despite readily availabile and detailed guidance such as PPG14 for England & Wales. Instead, the plantation forestry is described as an advantage because it means that the wind farm will have minimal environmental impact.

Wildlife assessment, particularly of avifauna, is superficial and does not make use of available information. Its conclusions do not reflect the information presented about birds and, again, give a best-case scenario.

Claims are made concerning carbon emissions which are incorrect and present only part of the story. It is suggested that there are no emissions from wind farms and that all carbon-balance issues are favourable. This is not so because vehicles are used to construct and maintain the wind farm and there are emissions associated with construction. While these should form part of the environmental audit, the most important issue at Derrybrien is the release of CO_2 from the peat soil as it oxidises during construction and as a result of catastrophic failures. The losses from the October 2003 event alone are equivalent to the energy production of three or four turbines for the lifetime of the project.

Events surrounding the bog slide of October 2003

The bog slide of October 2003 occurred after a period of dry weather, during construction of two turbine bases on a south-facing slope. The uppermost point was at Turbine 68 and Turbine 70 was swept away as a mass of peat slid for some 2.5 km. Failure appears to have occurred within the peat rather than at the peat-mineral interface. It is difficult to say exactly what happened, partly because evidence was washed away, but it seems that excavations were taking place for T68 while, immediately downslope, ponded water was being released beneath or over the road at T70.

The peat came to rest for some days but was re-activated by heavy rains in late October. It then became extremely fluid and flowed over 20 km down the Owendalulleegh River into Lough Cutra.

The evidence suggests that the failure may have resulted either from loading by excavation machinery or from the release of water into heavily-fissured peat or both. The initial failure led to a series of peat 'ribbons' separating from each other like zips and flowing off downslope, each supporting a line of plantation trees. The fault-lines corresponded to cracks from the forestry.

Unusually, the bog slide occurred during a spell of dry weather. The area had experienced an exceptionally dry summer in a run of dry summers which probably exacerbated cracking within the peat. If too much water entered the heavily-fissured peat either as rainfall or through pumping and drainage, this, combined with heavy machinery, may well have caused the failure.

Assessment of the geotechnical reports

Two geotechnical reports were produced after the slide, one by BMA, the other by AGEC. Both catalogue several factors to investigate but only one is used to calculate Factor of Safety (FoS) values. Both consider only static loading, not the impacts of vehicle movements or temporary loading.

The FoS values obtained indicate that 10 to 25 per cent of turbine locations showed a potential for instability. However, locations with high FoS values (i.e. stable) actually showed signs of instability while some locations with low FoS values showed no such signs, suggesting that the measurements

gave only a crude picture of stability. This may be partly because the calculations assume fixed values for shear strength, do not consider the fissured nature of the peat and make no allowance for localised temporary ponding or unsupported peat faces.

Both reports recommend 'robust' site drainage to stabilise the site sufficiently for work to continue. Given the tendency of drainage to concentrate water flows and the attendant dangers should the drainage system fail, it is not clear that it will produce the desired result in, say, storm conditions. As reported, the slide involved drained peat and occurred during dry weather.

Intensive drainage will result in the continued release of CO_2. If it causes major degradation of the peat through, for example, erosion, then the CO_2 release could continue long after the site has been decommissioned. It is also likely to result in increased sedimentation in the freshwater systems that arise in, or are fed by, the watershed. This is likely to have a significant impact on the quality of these systems, some of which are candidate SAC sites under EU legislation.

Assessment of scenarios

By integrating a range of spatial, topographic and habitat information into a drainage-pattern model for the whole of Cashlaundrumlahan, it is possible to view areas of significant peat cover in the context of a landform model. It is then possible to identify possible routes of movement should the peat fail again. These are akin to the avalanche corridors used in safety planning in the Alps.

From this, it is clear that the main bog slide arose in an area of moderate peat depth. The deepest peat is on the western limit of the summit on a slope that points towards Derrybrien and where there are three closely-spaced watercourses, any one of which might form a potential avalanche route. One of them flows into the village, past its school.

If the model examines the areas that show evidence of instability, it is clear that several of the corridors are linked to instability, including the deep peat on the western slopes. This significantly increases the threat posed by avalanche corridors directed towards Derrybrien.

The bog slide was not a single, freakish incident but part of a general pattern of instability within the area. There is evidence of other bog slides and of peat movement on the site and a bog slide was associated with another wind farm only four km to the north. It is reasonable to believe that another slide – perhaps small, perhaps as big as the last one – could occur.

The problem is that not enough is known about bog slides to predict where such an event might occur or what might trigger it. It is clear from the recent rainfall record that the region is in an extended period of weather drier than anything envountered over the last 15 years. The bog slide was associated with a prolonged dry period and there must be concerns that continued working on the site, either construction work or ongoing maintenance, may trigger a repeat event.

The general issue of wind farms, peatlands and renewable energy

The rationale for wind farms is that they reduce CO_2 emissions compared to fossil fuels. In most places, emissions from wind farms are associated only with the construction of the components and vehicular emissions linked to the site's development and maintenance. However, on peatlands, construction results in significant ongoing CO_2 release because they are substantial long-term carbon stores and this carbon is released when they are disturbed.

The Ramsar Convention recognises that peatlands are a habitat that is overlooked, misunderstood and under-recorded but which represent more than 50 per cent of the world's terrestrial wetland and which hold around 25 per cent of its soil carbon. They contain three times more carbon than the tropical rainforests and it is stored for thousands of years rather than the hundreds associated with most natural forests.

It is difficult to understand the logic of damaging long-term carbon stores to install devices whose purpose is to reduce emissions.

Introduction and objectives

IRELAND'S LARGEST WIND FARM proposal was consented through a series of planning permissions between December 1997 and July 2003, initially by Saorgus Energy and latterly by Hibernian Wind Power Ltd/Gort Windfarms Ltd. The site is on the summit of Cashlaundrumlahan Mountain[1] in the Slieve Aughty range, about 14 km east of Gort, County Galway and three km north of Derrybrien (fig 1). It is blanketed by up to 5.5 metres of peat and is now mostly covered by mature plantation forestry.

Construction of access roads and the first of 71 turbine bases started on 2 July 2003. On Thursday 16 October 2003, an estimated 450,000 cubic metres of peat slid down the southern side of the mountain. The slide initially stopped moving on 19 October, about 2.45 km downstream at an elevation of about 195 m and immediately upslope of a minor road known as the Black Road. At that time, most of the failed material lay on forestry land but it had surrounded an unoccupied house.

On 28 October, the peat began to move again following heavy rain. It crossed the Black Road and continued for 1.5 km to the Owendalulleegh River, whence it 'coursed along the Derrywee River and meandered for 20 miles to Lough Cutra, the source of Gort's domestic water supply'.[2] At a Derrybrien Co-ordination Meeting held on 17 November 2003 to discuss the impact of the bog slide, initial estimates of the impact on Lough Cutra indicated that more than 50 per cent of fish in the lake had been killed, about 50,000 fish of all species and age groups.[3]

Hibernian Wind Power halted construction and two geotechnical investigations were commissioned. On the basis of the results, the company acknowledged that the landslide was caused by its activities but contended that the risk of such an outcome could not have been foreseen. Its intention is to resume construction, adopting modifications to working practices recommended by the reports.

The University of East London was engaged in June 2004 by V.P. Shields & Son, on behalf of the Derrybrien Development Cooperative Society Ltd and individual landowners whose lands were affected by the bog slide[4] to provide an independent assessment of the development. The authors visited the site on 8 June 2004 and were shown around by Hibernian Wind Power staff. The objectives of their report are:

- to assess the adequacy of the Environmental Impact Statement and the Environmental Assessment compiled to support the planning applications submitted for the wind farm development;
- to highlight and consider any issues relevant to the development but not considered in these Environmental Impact Assessment reports;
- to assess in similar terms the two geotechnical investigations undertaken after the peat slide.

It is in two sections. Part 1 deals with issues prior to the slide, including the pre-development state of the site, the issues to be considered in an EIA and the EIA reports actually produced for the development. Part 2 deals with the slide, its possible causes, the analyses of the event carried out to date and some scenarios for the future.

1 Irish National Grid Reference M 589 049, summit altitude 365m above mean sea level at Malin Head (Malin datum).

2 Ronnie O'Gorman, *Galway Advertiser*. The river has variant names and spellings: the Derrywee, the Owendalulleegh and the Abhainn Da Loilioch River. (The distance the slide travelled was more like 20 km.)

3 The Shannon Regional Fisheries Board confirmed the estimate in a press release of 18 November 2003.

4 Mary Curley, Michael Mahony, Joe Slattery, Frances Broderick and James Kelly.

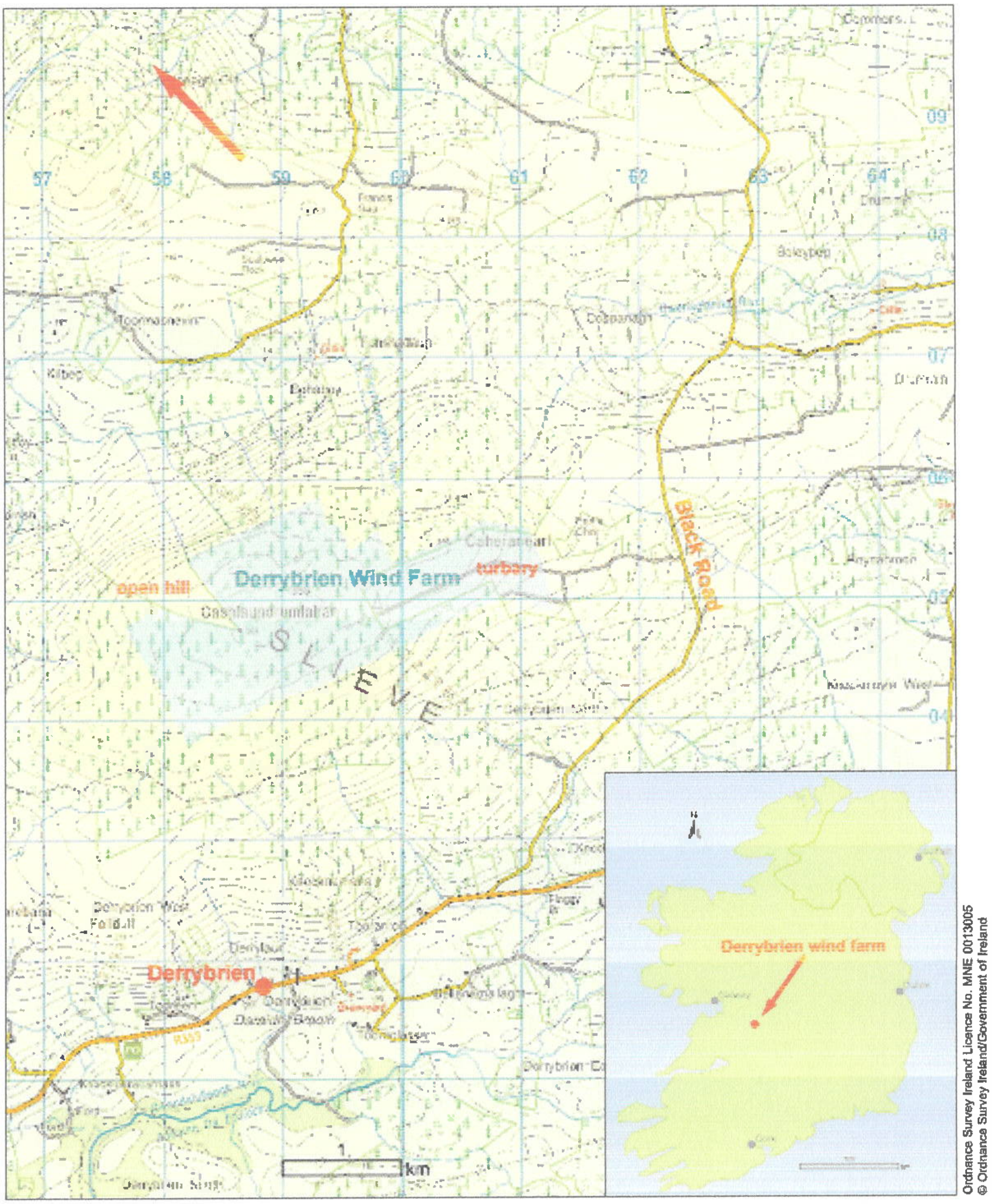

Figure 1: The location of Derrybrien wind farm (shaded pale blue), based on Ordnance Survey Ireland 1:50,000 Discovery Series, Sheet 52. (The arrow in the upper left corner points to the Sonnagh Old wind farm – see page 120.)

PART 1

Issues prior to 16 October 2003

Chapter 1

Development and Environmental Impact Assessment

FOR THE PERIOD LEADING up to the bog slide, the report is concerned with:

- an assessment of the area prior to the development;
- an assessment of the proposed development;
- identification of factors relevant to an assessment of its impact;
- observations about the impact assessment the developers actually carried out.

The process of Environmental Impact Assessment (EIA) is central to Part 1 of the report. The legislative background to EIA and the available guidance are therefore reviewed below and set in the context of the Derrybrien wind farm proposals.

1.1 *General background to Environmental Impact Assessment*

The European Communities Directive 85/337/EEC first established a legislative requirement within the European Union for Environmental Impact Assessment (EIA) in 1985 and identified a number of activities for which an EIA would be required. These were later transposed into Irish legislation through various planning and development consent systems (EPA 2002). In 1997, the original Directive was amended by Directive 97/11/EC to encompass a wider range of more clearly specified developments for which EIA would be a legal requirement. Member states had to implement this amending legislation by 14 March 1999 (Bond, undated).

A considerable body of literature concerning EIA, EIS and EA is freely available. Much of this provides detailed and helpful guidance about the assessment process, how it should be approached, what sorts of factors should be considered for a given development type and even where information can be obtained (e.g. Essex Planning Officers' Association 1994, Morris and Therivel 1995, Gilpin 1995, Weston 1997, Petts 1999, European Commission 1999).

Guidance about the details required for EIA varies to a degree from author to author and from country to country but there is a remarkable degree of consistency in general structure. This is perhaps not so remarkable given that the approach established by the US Environment Protection Agency forms the model for many systems around the world. The key elements generally recognised as forming part of an EIA and explicitly set out for EU Member States in Article 5(1) of Directive 97/11/EC, consist of:

- Description of the physical nature of the project and its processes;
- Outline of the various alternatives considered and the reasons for the final choice;

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- Description of the physical nature of the project and its processes;
- Outline of the various alternatives considered and the reasons for the final choice;

- Description of those parts of the environment likely to be significantly affected by the project;
- Description of the the project's likely effects on the components described above;
- Description of the measures to be taken to minimise or mitigate these effects.

These form the essential components of an EIA but they must then be incorporated into the planning process which has its own clearly-defined stages. Within the European Union, these stages are recognised as:

- *Project Preparation* – the developer prepares the proposals;
- *Notification to Competent Authority* – some Member States require prior warning of a development proposal;
- *Screening* – the Competent Authority considers whether a project requires an EIA;
- *Scoping* – the developer determines the range of environmental issues that must be addressed by the EIA;
- *Environmental Studies* – the developer gathers environmental information;
- *Submission of EIS* – the report is presented to the Competent Authority;
- *EIS Review* – the Competent Authority considers whether the EIS is adequate;
- *Consultation* – the EIS is subject to a consultation process involving statutory bodies and interested parties;
- *Consideration of the Environmental Information* – the Competent Authority considers the EIS and consultation comments prior to making a decision about the application;
- *Announcement of Decision* – the decision is made public, along with reasons and mitigation measures to be adopted;
- *Post-Decision Monitoring* – if the project is approved, there may be a requirement to monitor subsequent project effects.

Not all these steps are legal requirements under Directives 85/337/EC and 97/11/EC but all are recommended to Member States as good practice and have been formalised by some into national law. However, as far as the wind farm development at Derrybrien is concerned, all the steps except the last fell within the period prior to the bog slide and can be considered in Part 1 of the report.

1.2 *Project Preparation*

Strictly speaking, the project is not one development but three because three separate planning applications were made to Galway County Council. The details are dealt with in section 7.1 and it is sufficient to note here that the composite application involved the construction of 71 wind turbines within an area of some 345 hectares across the summit of Cashlaundrumlahan. In contrast with the developer's approach, in which two separate Environmental Statements were produced (they are considered in section 7.5), the scheme will be considered here as a single development proposal.

1.3 *Notification to Competent Authority*

There is no requirement in Irish legislation for a developer to notify the planning authority of an intention to submit a planning application.

1.4 *Screening*

Directive 85/337/EC specifies a range of development proposals for which EIA is mandatory but wind farms are not included. Consequently, the first EIA Directive is not relevant to the wind farm proposal at Derrybrien. The amending Directive 97/11/EC extended the list of developments for which EIA is required and wind farms are explicitly listed in Annex II of the Directive. Member

- Description of those parts of the environment likely to be significantly affected by the project;
- Description of the the project's likely effects on the components described above;
- Description of the measures to be taken to minimise or mitigate these effects.

These form the essential components of an EIA but they must then be incorporated into the planning process which has its own clearly-defined stages. Within the European Union, these stages are recognised as:

- *Project Preparation* – the developer prepares the proposals;
- *Notification to Competent Authority* – some Member States require prior warning of a development proposal;
- *Screening* – the Competent Authority considers whether a project requires an EIA;
- *Scoping* – the developer determines the range of environmental issues that must be addressed by the EIA;
- *Environmental Studies* – the developer gathers environmental information;
- *Submission of EIS* – the report is presented to the Competent Authority;
- *EIS Review* – the Competent Authority considers whether the EIS is adequate;
- *Consultation* – the EIS is subject to a consultation process involving statutory bodies and interested parties;
- *Consideration of the Environmental Information* – the Competent Authority considers the EIS and consultation comments prior to making a decision about the application;
- *Announcement of Decision* – the decision is made public, along with reasons and mitigation measures to be adopted;
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States have a certain flexibility in relation to Annex II developments in that they can decide if an EIA is required on a case-by-case basis or they can specify national thresholds to determine what developments require assessment. Ireland chose the threshold approach and Statutory Instrument No. 93/1999 states that all wind farms with more than five turbines or whose capacity is over five MW are subject to EIA. A development the size for Derrybrien would thus be legally required to undertake an EIA as part of the planning process. In practice, the final phase of the scheme, involving 25 turbines, required EIA because it was submitted after S.I. No. 93/1999 came into force. The planning sequence is discussed in detail in section 7.3.1.

1.5 *Scoping*

Although detailed guidance on scoping was not published by the European Commission until 2001 (European Commission 2001), the subject has been covered extensively in the literature and the Commission's guidance in relation to environmental impact assessment and cumulative impacts (European Commission 1999) gives a valuable and informative treatment of the subject. Scoping is defined by the 2001 Guidance:

> Scoping is the process of determining the content and extent of the matters which should be covered in the environmental information to be submitted to a competent authority for projects which are subject to EIA.

More particularly, the guidance provided for the assessment of cumulative impacts has the following to say about the importance of scoping:

> Scoping is a well established principle in EIA and much guidance has already been produced on the subject . . . The objective of undertaking scoping is to identify issues that are to be addressed in the EIA and to focus the assessment on the most potentially significant impacts . . . Scoping is generally accepted to be one of the main factors in a successful EIA . . . Decisions made at the scoping stage of the EIA are of fundamental importance to the project as they determine, in the most part, what will follow.

What follows in Part 1, sections 2 to 6 is largely a scoping exercise for the Derrybrien development based on the guidelines set out by the European Commission. This is then compared (in section 7) with the EIA reports that accompanied the planning applications. This provides a means of judging to what extent these adequately addressed the issues relevant to, and the potential impacts of, the project.

Chapter 2

Scoping – the ecological framework

2.1 *Establishing geographical (and temporal) limits for the EIA*

One of the key steps in the EIA process is determination of the geographical boundary over which assessment will be undertaken. This in turn determines the environmental issues that the EIA must address. Although providing an obvious limit, the area encompassed by the planning applications rarely proves to be an adequate boundary for an EIA. Consider factors such as visual impacts or noise and it soon becomes evident that impacts may involve areas some distance beyond the bounds of the development. Other factors may have a seasonal aspect or a cumulative geographical effect – it is important to consider limits over time as well as space.

The geographical area embracing all possible impacts will rarely be clear at the outset of the exercise because, as more factors are considered, so they bring with them their own geographical boundaries of possible impact. It is important to return to the boundary question repeatedly during the scoping process as additional factors are introduced because each may have an influence on the final boundary. This iterative approach is fundamental to the scoping process and is particularly important in ensuring that indirect and cumulative impacts as well as impact interactions are fully addressed. As the guidelines for this process observe (European Commission 1999):

> Indirect and cumulative impacts and impact interactions may well extend beyond the geographical site boundaries of the project. Determining the geographical boundaries will therefore be a key factor in ensuring the impacts associated with a project are assessed comprehensively wherever possible ... Additional data may need to be gathered to cover wider spatial boundaries, taking into account the potential for impacts to affect areas further away from the site than if just direct impacts were considered. Consideration should be given to the distance that an impact can travel and any interaction networks.

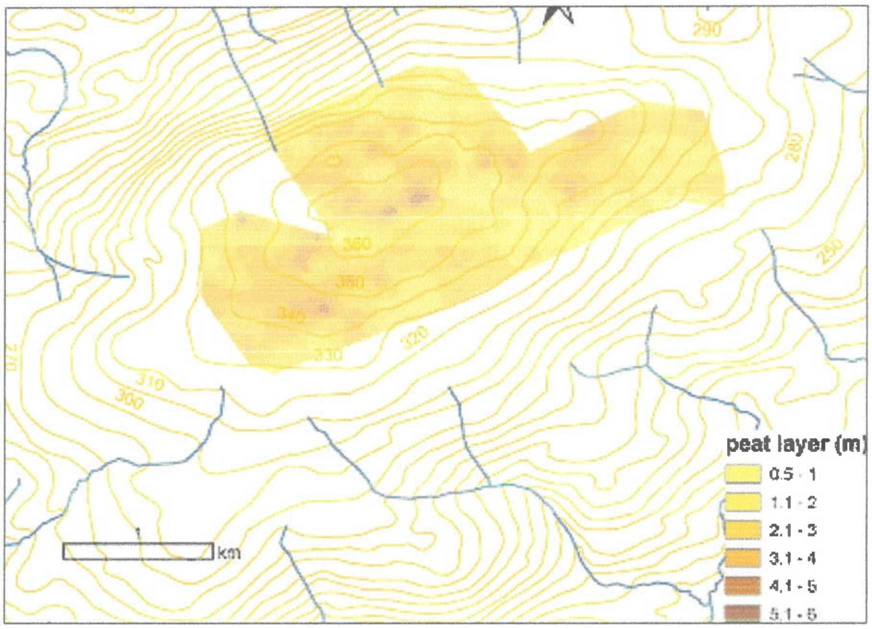

Figure 2.1: The depth of peat recorded for Cashlaundrumlahan within the area of development.
Surface contours give some indication of slope, while the streamlines indicate patterns of drainage.

Original peat depth data recorded by Malone O'Regan McGillicuddy, Consulting Engineers, Cork.

2.2 *Characteristics of the Cashlaundrumlahan summit*

The limits of the Derrybrien wind farm development embrace most of the broad summit of Cashlaundrumlahan, one of the northernmost peaks of the Slieve Aughty Mountains which lie towards the western seaboard of Ireland (inset, fig 1). The mountain range appears on the simplified geological map of Ireland (GSI 2004) as a massif of Devonian Old Red Sandstone[1] rising from lowlands of Burren (karst) limestone. The west of Ireland is a classic location for the extensive development of peat soils and the Cashlaundrumlahan summit is covered by these to a thickness of between 0.4 and 5.5 metres (average 2.5 m). The distribution of this within the area of the development can be seen in fig 2.1.

The environmental assessment should recognise that a large proportion of the issues to be addressed arise from the fact that peat is the dominant soil type. The first stages of information-gathering to establish its ecological baseline should involve a detailed review of peat and its ecological characteristics in order to begin identifying the key factors that may be relevanct to the assessment.

2.3 *Peat*

Peat has been defined as 'partly decomposed plant material that has accumulated in situ (rather than being deposited as a sediment) as a result of waterlogging' (Bragg and Lindsay 2003). When peat-forming plants die, they do not decay completely because their remains become waterlogged as a result of constant, regular rainfall. This constant waterlogging excludes air and limits the range of active decomposer organisms. Instead of decomposing entirely to carbon dioxide and water when they die, some of the plant remains from the surface vegetation become incorporated into a layer of partly-decomposed vegetation beneath the surface. This 'soil' has been accumulating for thousands of years to become, in places, several metres thick. Its only water supply is rainfall and the low permeability of peat means that the water drains away very slowly. The peat remains saturated almost up to the surface, maintaining the anaerobic conditions necessary for its own preservation. Such persistently wet, nutrient-poor conditions favour the growth of the bog-moss Sphagnum, which carpets much of the ground and provides the majority of the plant material that eventually becomes peat. Sedges, dwarf shrubs and other specialist vascular plants grow rooted in this carpet as though it were the surface of the soil.

The peat may be little decomposed and retain recognisable fragments of Sphagnum and other living plants that formed it or it may be more strongly humified and amorphous. The degree of decomposition (humification) can be estimated in the field by applying the 'squeezing test' of von Post and Granlund (1926). This yields a humification value ranging from H1 (completely undecomposed) to H10 (highly decomposed). As material passes down through the living surface layers (or, more accurately, is increasingly buried by fresh growth at the surface), its degree of decomposition increases as long as it continues to be exposed to oxygen by fluctuations in the water table. However, once it enters the lower layers of permanently waterlogged peat and remains bathed by the nutrient-poor, acidic water of these layers, most of the decomposing organisms become inactive and further breakdown occurs only by slow anaerobic fermentation, which produces methane.

Although regarded by geologists as a drift deposit and by pedologists as a soil, many types of peat contain negligible quantities of mineral material. A silt-laden river contains more mineral matter by volume than does the same volume of bog peat. Bog peat accumulates under conditions where mineral inputs are extremely low and the dry mass content of peat is almost entirely organic. This is because peat bogs receive practically all their water and mineral nutrients directly from the

[1] Bedrock within the wind farm boundary varies from 'medium-grained pale brown thinly to massively bedded sandstones' towards the north and east to 'fine-grained pale pink thinly to medium bedded silty sandstones' towards the south and west and 'medium bedded conglomerates interbedded with sandstones' in the north. In some places, it is overlain by glacial till (AGEC 2004). One of the planning documents (Saorgus Energy Ltd. 2000, page 38) indicates that 'shale bedrock' will be quarried for road construction.

atmosphere as rain, snow, fog or other forms of atmospheric deposition. Inputs of water are high in the high rainfall areas where peat bogs are relatively frequent or even abundant but the input of minerals is generally extremely low.

Peat bog soil may be largely organic matter but, when calculated by volume, in undrained peat the quantity of even this organic material is typically only three to six per cent: the principal constituent of peat is water. Hobbs (1986) illustrates the point with the example that five metres of fibrous peat may contain 4.7 metres of water but only 0.3 metres of plant matter. The figures are even more dramatic by weight, yielding only two per cent solid matter and 98 per cent water. Hobbs concludes that some powerful agency must give the peat its demonstrably solid properties.

The secret lies in the colloidal nature of peat, which relates to the unusually high cation exchange ability (CEA) of Sphagnum bog moss. This CEA enables Sphagnum to utilize the minute quantities of plant nutrients offered by rainwater to survive in the bog habitat (Clymo 1983). Essentially, the process works through electrostatic binding of positively charged metal cations to negatively charged exchange sites on the Sphagnum cell walls. Exchange sites that are not occupied by metal cations can bind water instead, which is adsorbed tightly onto the surface of the plant tissues. Water in peat exists in three interchangeable states:

State 1 water held loosely (at suctions <10 kPa) in large spaces ranging from pipes, cracks and other large voids which can be drained under gravity;

State 2 water held by capillary forces (>10 kPa) in narrower cavities and some cell structures;

State 3 water that is bound tightly to the surfaces of organic matter, being held by forces much stronger than the two previous states (at suctions up to 20 MPa).

When peat is drained or otherwise dried, water in voids or held by capillary action (states 1 and 2) is withdrawn but it is replaced by air and there is no change in volume but, when adsorbed (state 3) water is lost, it is not replaced by air.

Instead, the particles are drawn closer together, reducing the size of the water-filled spaces between them (Ward 1975). The peat shrinks, undergoes a permanent material change and cannot be re-hydrated. This occurs to such a degree that peat bales and turfs which have been dried sufficiently to remove at least some of the adsorbed water can be used as a lightweight, underwater engineering fill, remaining strong and stable so long as the bales are permanently submerged and never re-exposed to oxygen.

The proportions of water held in each of states 1 to 3 can be expected to change with the degree of decomposition (humification). For example, as the large storage cells of Sphagnum plants are broken open and plant fragments generally become more tightly pressed together, the proportion of capillary (state 2) water to loosely-held (state 1) water increases. Since the adsorption complexes on the cell walls are weakened as decomposition proceeds, we can anticipate changes in both the total and relative quantities of state 3 water. As this acts as the real 'glue' of a peatland, giving it the properties of a solid remarked upon by Hobbs (1986), progressive water removal will have important implications for these properties. For example, the liquid limit of peat (the water content at which it begins to flow like a fluid) is high compared with that of other soils (including clay which has a similar CEA). In other words, peat can hold much more liquid than other soils before it starts to flow like a liquid because the peat particles are less dense than mineral material and can be held together more firmly by the adsorption complex. However, this liquid limit declines with increasing humification because, as the plant tissues break down, so the strength of the adsorbtion complex steadily weakens.

The physics and chemistry of the peat, the water in the peat and the nature of the organic matrix exert important influences on the engineering properties of peat soils. For a development proposal involving possible drainage effects on a peatland ecosystem, these are pertinent factors and must be addressed by the EIA process.

Peat soils occur from the equator to the arctic in a wide variety of forms and are associated with a

wide variety of habitats. It is important to be clear precisely which type or types of peat are involved with the proposal. At Cashlaundrumlahan, it forms a habitat known as 'blanket bog' or 'blanket mire',[2] which is one of the major peat-forming systems found on the Atlantic seaboard of Europe (Tansley 1939). The properties of the blanket peat soil are intimately bound up with the characteristics of the blanket mire habitat that it supports.

The next stage in this scoping exercise involves a review of the blanket mire habitat.

Plate 2.1: Typical Derrybrien bog vegetation, with heath milkwort (*Polygala serpyllifolia*) and purple moor grass (*Molinia caerulea*) as characteristic oceanic species within a bog moss (*Sphagnum capillifolium*) hummock [nanotope] capped by heather (*Calluna vulgaris*).

2.4 *Blanket mire*

2.4.1 *General characteristics*

The global distribution of blanket mire is quite limited although it occurs widely in the UK and Ireland. It is found less extensively along the western seaboards of Scandinavia and Canada and in a few locations within similar southern-hemisphere latitudes, including the Falkland Islands, where it dominates the landscape (Lindsay et al. 1988). It is generally associated with temperate climates characterised by frequent rainfall. For example, blanket mire in northern Scotland experiences some precipitation on at least 180 days each year (Lindsay et al. 1988). Cloud cover and rainfall tend to be greatest on hill summits and peat formation is often vigorous on high-level plateaux and gently-rounded hill tops.

In locations where blanket mires have formed, the water supply from precipitation is sufficient to maintain the peat layer in a saturated state on level areas and even on moderate hill slopes. As the name implies, in areas with a suitable climate the peat deposit may come to blanket the hills and valleys of an entire landscape provided the hill slopes are not too steep. The peat is thickest where it overlies basins, plains, broad ridges and level plateaux in the substratum and here it is possible for lakes and pools of open water to form in the mire surface. Since bog pools tend to form on areas of deep peat and the deepest peat is often found on hill summits, the result gives the rather curious impression that 'all the water sits at the top of the hills' – a widely-quoted saying from the Falkland Islands. Fig 2.2 gives a schematic view for part of a blanket mire.

Blanket mires generally consist of several peat-forming units interlinked by their hydrology into a complex mosaic. The term for this is a 'macrotope' while the individual peatland units which together make up the interconnected blanket mire complex are termed 'mesotopes' (Ivanov 1981). These may be distinguished from each other most readily by their differing and distinct regions of surface pattern, which arises because some areas of the bog surface hold water as shallow pools or hollows while other areas between the pools form hummocks and ridges. The pattern formed by this hummock-hollow arrangement results from growth of differing Sphagnum species which create these alternating structures. The pattern itself is termed a 'microtope'. The microtope is thus made up from individual structural elements such as hummocks or shallow hollows. These are termed 'nanotopes'. They are created, and characterised, by differing types of bog vegetation.

The whole assemblage, from individual hummock to large peatland mosaic, is created from a hierarchy of interlinked structures interconnected by their hydrology (fig 2.3).

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2 'mire' is the technical term for any peat-forming system.

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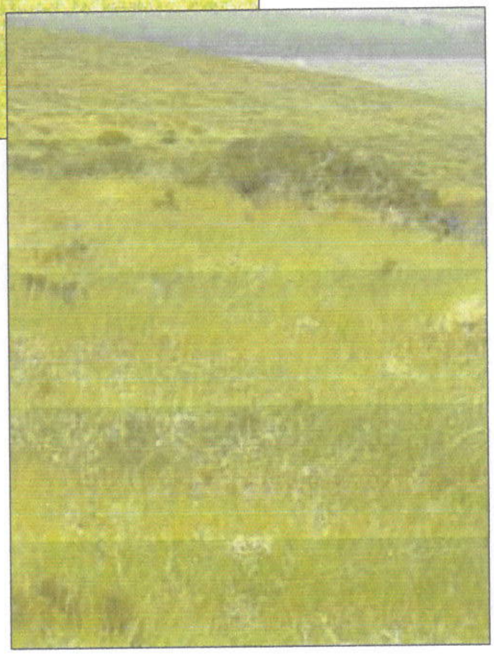
[2] 'mire' is the technical term for any peat-forming system.

2.4.2 Blanket mire at Cashlaundrumlahan

The site retains many characteristics of a typical blanket mire ecosystem despite extensive disturbance from a range of human activities including peat cutting and afforestation. In some parts, the open blanket bog, with its characteristic vegetation of Sphagnum bog mosses, can still be found while even in such disturbed areas as the forestry plantations it is possible to find a range of bog plants growing within scattered Sphagnum bog moss carpets.

In the case of Cashlaundrumlahan, the blanket mire complex (macrotope) represents the whole assemblage of peatland units that interlink to form the continuous peat landscape centred around, and dominating, the Cashlaundrumlahan massif. These individual peat systems are now quite difficult to see because extensive forestry has obscured much of the blanket mire structure. Nevertheless, a small portion of characteristic watershed mire can be seen on the summit ridge, where an area of bog pools has not been ploughed for forestry. Here, the bog surface shows a repeated pattern (microtope) of pools and intervening ridges on which there are both high and low hummocks. Some of the blanket mire features still to be found are illustrated in plates 2.1 to 2.3.



Plates 2.2: Typical view across the northern slopes of the watershed blanket mire (mesotope) that dominates the summit of Cashlaundrumlahan. In the upper photograph a series of hummocks (nanotopes) can be seen as a repeated structural motif (microtope) scattered across the slope but, in this case, there are no pools, only terrestrial elements forming the microtope pattern.

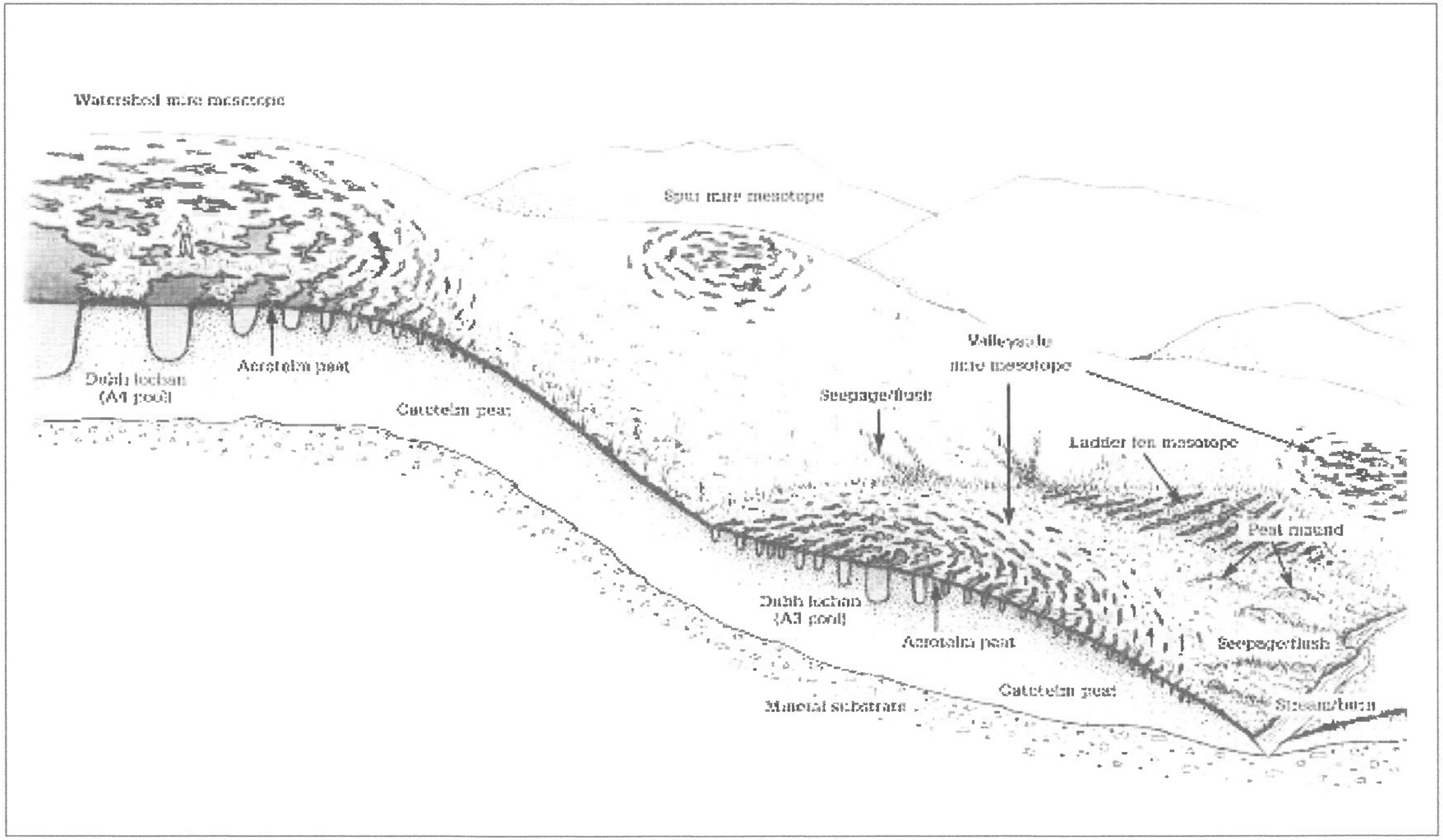


Figure 2.2: Schematic representation of blanket mire, adapted from Lindsay et al. (1988), showing the relationship between peat depth and slope of the underlying mineral substrate as well as the physical (and associated hydrological) inter-relationships between the various structural components of a blanket bog complex [or macrotope]. Terms are explained in sections 2.4.1 and 2.4.2. (Depth of peat exaggerated compared to horizontal scale).

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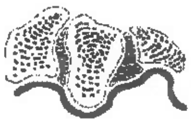
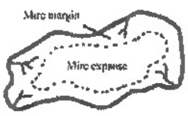
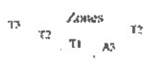
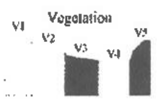
Feature	Hierarchical level	Description	Hydrological relationship	Utility for classification and evaluation
	Supertope	Position of linked mire units within the regional landscape	Overall climate and regional water-table	Regional overview
	Macrotope	Assemblage of hydrologically linked mire units	Individual bog units hydrologically linked via intervening fens and stream-courses	Identification of boundary for minimum, hydro-logically sound, conservation unit
	Mesotope	Distinct, recog-nisable hydro-topographic unit.	Inputs of rainfall, outputs of seepage, drainage and evapo-transpiration	Identification of individual, recognisable units for comparison
	Mesotope	Distinction between mire-margin and mire expanse.	Broad patterns of water movement within the mesotope, from high ground to low ground	Recognition of 'core' and 'marginal' zones; in Europe, the margin often partly removed
	Microtope	Repeated surface pattern - *e.g.* pool system.	Surface pattern reflects hydrology of acrotelm layer and overall mire gradient	Identification of naturalness; source of comparative diversity
	Nanotope	Individual surface features (*e.g.* hummock, pool)	Small-scale water movements within the acrotelm	Source of niches for individual species; com-parison of diver-sity and damage
	Vegetation	Distribution of vegetation within surface structures.	Ultimate control of acrotelm and surface water movement	Source of comparative diversity; indicator of 'naturalness'

Figure 2.3: Hierarchical relationship between the various functional levels of peat bog systems, from the large-scale concept of mire landscapes [supertopes], to the smallest structural level of hummock or hollow [nanotope], and the hydrological relationships that operate at each of these levels (adapted from Lindsay et al. 1988).

2.5 *Soil structure*

The hierarchy of hydrological structures that contribute to the orderly functioning of a bog does not end at the soil surface. The soil profile of an intact bog has a distinctive two-layered structure (Ingram 1978) which differs fundamentally from that of mineral soils and is intimately linked to the processes that maintain the peatland system.

Plate 2.3: Example of the only bog pool complex surviving on Cashlaundrumlahan. As might be expected, this indicates an area of deep peat on the summit ridge and represents a watershed mire mesotope with a typical microtope pattern of pools.

The upper layer, known as the *acrotelm*, is a fibrous surface skin, typically around 0.5 m thick, that occupies the layer of the bog between the mire surface and the lowest position of the water table in dry summers. Its uppermost part acts as the soil surface for vascular plants and a vertical profile through the acrotelm displays the series of changes that the vegetation undergoes as it is progressively assimilated into the body of peat. It is first buried by fresh growth at the surface, then dies and partially decomposes into what is commonly known as peat. The acrotelm is the equivalent for a peat soil of the parent material (usually rock) of a mineral soil although it lies at the top of the soil profile rather than at the base.

The acrotelm consists essentially of a matrix of plant material bound together by live roots. It has considerable tensile strength and forms a coherent surface that can bear weight. Perhaps most important, however, it plays a key part in maintaining the hydrological stability of a peat bog. Near the mire surface, structures in the acrotelm consist largely of vertical moss stems with many cross-links formed by branches. Spaces between these structures are frequent and relatively large and the bog water table is thus able to move up and down through this part of the acrotelm with ease while excess water following heavy rain can flow laterally through these large spaces in a more controlled way, as it would through a sponge, rather than as dangerous sheet flow across the bog surface. Lower in the profile, the stems weaken and break and branches are pressed more tightly together. Spaces are smaller and less oriented and vertical water-table movement thus becomes progressively more difficult, as does lateral seepage. Towards the base of the acrotelm, stems and branches are fragmented and pressed together, leaving few spaces and and with little orientation. Water movement, either vertically or laterally, is extremely slow in this zone.

During periods of rainfall, the water table rises so that the large spaces in the upper part of the acrotelm become water-filled. The coarse structure offers little resistance to water movement – in other words, it is highly permeable – so that the water can drain downslope quite easily. During dry weather, on the other hand, drainage is progressively impeded as the water table falls deeper into the acrotelm. It could be said that the bog allows water to flow easily during wet weather but, once the rain stops and the acrotelm begins progressively to empty, it holds on increasingly tightly to the water that remains. This mechanism is important for mire vegetation in that during heavy rain it permits rapid surface runoff in a way that might otherwise wash away the rootless Sphagnum carpet but it does not allow the water table to fall below the minimum level required to support 'water-loving' (hydrophytic) mire plants at the bog surface (Ingram and Bragg 1984).

Beneath the acrotelm is the bulk of the peat deposit which, on Cashlaundrumlahan, is more than five metres deep in places. This lower deposit, known as the *catotelm*, remains completely saturated at all times under natural conditions, losing water slowly through gravity-driven seepage but being constantly re-supplied from the acrotelm. It may also be drained by systems of underground (soil) pipes which may or may not communicate with the surface. The catotelm provides an undisturbed peatland with its overall shape and, because catotelm peat can be preserved only if it is waterlogged, this shape is an expression of the peatland's hydrology (Ingram 1982).

2.5 *The blanket mire environment – an integrated system*

These various levels of soil structure and ecosystem organisation are linked through hydrological processes. Damage to the acrotelm, for example, may lead to hydrological changes to the bog unit as a whole which in turn may bring about changes in the small-scale surface pattern. In hydrological terms, the peat blanket is an integrated system that absorbs all the rain that falls on its surface and transmits it to the lower slopes of the mountain in as controlled a way as possible through a variety of interconnecting processes that operate at different scales and speeds.

Once below the mire surface, water moves much more slowly downslope than it would if the bog were not present because it has to find its way through small spaces in the peat matrix in a process known as seepage. Seepage is driven by gravity and so is always directed along flow-lines that cut directly across (perpendicular to) the surface contours. As the slope steepens towards the edge of the

peat blanket, the flow-lines converge into shallow valleys which focus the seepage into flushes which eventually form streams that emerge from the edge of the peat.

The bog peat forms a protective layer over the bare rock and mineral soils beneath, shielding them from the erosion that would otherwise result in such high-rainfall areas. The quality of the water that is discharged into streams fed by blanket mire run-off, and thence into rivers, is quite different from the runoff that would be derived from a similar mountain with no peat cover in its chemical composition, in the quantity of sediment that it carries and in the pattern of water flow. The presence of blanket bog in the headwaters of a catchment exerts a strong influence on the ecology of streams, rivers and lakes within the catchment.

The structure and functioning of mires is described in a number of substantial texts (e.g. Osvald 1949, Moore and Bellamy 1974, Gore 1983, Lindsay et al. 1988, Lindsay 1995, Feehan and O'Donovan 1996) and the interested reader is referred to these sources for more information about these ecosystems.

Summary of Chapter 2

1 The definition of the boundary required for scoping and assessment is an iterative process that develops from the range of information found to be required.

2 The development site is almost entirely covered by blanket bog ranging from less than 0.5 metres to more than 5.5 metres in depth.

3 Peat is an unusual 'soil' in being mostly water but with a small amount of organic matter created by Sphagnum bog mosses that grow, but only partially decompose, in waterlogged conditions. There is very little mineral matter in a peat soil.

4 The peat matrix is held together by hydrostatic forces arising from strong surface charges present on the Sphagnum fragments. Some of the water in peat can be removed by gravity drainage but this tightly-bound water is difficult to remove except by slow drying and decomposition of the peat.

5 Peat has a high liquid limit, meaning that it can hold much more water than most soils before acting as a liquid but this limit is reduced by oxidative decomposition.

6 Blanket mire is a form of peat that typically develops in oceanic climates and occurs as a blanket of peat that covers all but the most steeply-sloping parts of the landscape.

7 The bog soil consists of two distinct layers – a thin upper acrotelm which is fibrous and contains the living vegetation and the fluctuating water table, and a deeper catotelm which represents the main mass of accumulated peat and which remains waterlogged and sealed from the atmosphere by the acrotelm under natural conditions.

8 Although individual structural components can be identified within a blanket mire landscape, many of these are hydrologically linked into complexes or as part of a hierarchical hydrological series. Damage to one of these features, or to one of the peat-soil layers, is likely to cause harm to other parts of the blanket bog system.

Chapter 3

Scoping – pre-development conditions at Derrybrien

HUMAN IMPACT CAN RESULT in significant changes to different elements of a mire ecosystem which then influence the way in which the mire functions. Some of these are reversible to a greater or lesser degree whereas others are irreversible and can lead in some cases to complete disintegration of the ecosystem. Some effects of human impact are considered in this section first in a general sense and then with specific reference to identifiable instances within the area of the Derrybrien wind farm.[1]

A key step in EIA scoping involves the identification of existing conditions on the development site and associated ground. The land-use activities hitherto associated with a site and their impact on it should be catalogued with some care. Not all forms of land-use are necessarily damaging nor are all aspects of pre-development conditions on a site associated with harmful intervention or negative site characteristics. Nature conservation is often considered to be a form of land use, for example.

Statutory designations associated with the site are certainly relevant to scoping partly because they may lead to changes to the boundary considered necessary to complete a comprehensive EIA but also because they are likely to impose particular constraints on development proposals. Although these issues form part of the iterative evaluation sequence and are an important part of the scoping process, clarity of presentation is best served in practice by leaving the listing of designations and features of interest until the geographical scope of the EIA has been determined.

A detailed description of statutory designations and features of conservation value can be found in section 6.3.

3.1 *Agriculture*

3.1.1 *General context*

Most upland blanket mire is, or has at some time been, grazed by large wild herbivores such as deer and, more intensively, by domesticated sheep and/or cattle. In this context, grazing involves the direct removal of vegetation and the addition of nutrients in excreta. There are potential effects on the species composition of vegetation as a result of selective feeding and nutrient enrichment and on peat formation processes in the acrotelm through alteration of the supply of raw plant material and increased activity of the decomposer microflora. Associated trampling compresses the acrotelm and alters its water transmission characteristics so that the frequency of surface runoff increases. If trampling becomes more intense, it can break up the Sphagnum carpet to leave areas of bare peat exposed to the actions of rain and frost. This in turn can lead to erosion of the peat. Acute degradation of blanket mire through overgrazing by sheep has been reported from west Galway (Douglas 1998) whilst Lindsay et al. (1988) report Dr M.W. Holdgate's observation that 'the only areas of significant peatland erosion in the islands of Tierra del Fuego were associated with the world's most southerly sheep farm'.

Blanket mire is often burnt as part of a systematic programme intended to improve the quality of grazing. A light, controlled fire removes only the taller vegetation and old dead leaf-litter, encouraging fresh new growth. However, few fires on blanket bog are controlled in such a way. Most burn off all the surface vegetation including the moss layer. Even the peat can catch fire. This leaves a bare peat surface through which – in the most oceanic parts of Europe – purple moor grass (*Molinia*

[1] For a more wide-ranging review of human impacts on blanket mire systems, see chap 5 & 6 of Lindsay et al. (1988).

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caerulea) and deer grass (*Trichophorum cespitosum*) emerge to form a green sward which is palatable to animals for a month or two. The surface beneath this sward is largely bare and unprotected from rain and frost and, once again, this can lead to peat erosion.

Drainage is also believed to improve the quality of grazing and to make blanket mires safer for grazing animals. Moor gripping involves the digging of ditches some 10 to 20 metres apart to promote the growth of heather (*Calluna vulgaris*) and to drain particularly wet areas where sheep may become bogged down and drown. In the immediate vicinity of each ditch, the water table is drawn down into the catotelm, allowing air to enter the peat so that oxidative decomposition begins. For moor grips, the marked effect is restricted to a narrow strip of ground either side of each ditch (Stewart and Lance 1983). There is little widespread drainage of the catotelm because its low permeability resists dramatic water loss. The main function of the grip is to collect water seeping through the acrotelm and direct it to the edges of the bog system. The supply of seepage water to the surface of peat blanket downslope is thus reduced. This affects the vegetation since some bog species are sensitive to water table changes of only a few centimetres (Ivanov 1981). It also deepens the acrotelm, again promoting decomposition. The intensity of these effects increases with the intensity of drainage.

The eventual outcome of peat drainage is most dramatically illustrated by the results of past agricultural drainage projects on lowland peat:

> Dewatering of wetlands for agricultural purposes in the western Netherlands began as early as the 9th century. By the 16th Century, serious subsidence had occurred to the extent that dikes, canals and windmills were built to avoid inundation. In the Sacramento-San Joaquin Delta of California and the Florida Everglades, organic soil-related subsidence occurs at a rate of one to three inches per year. One of the contributing factors to this subsidence is microbial decomposition of organic matter that occurs when oxygen becomes available upon dewatering. This process converts organic carbon to carbon-dioxide gas and water when oxygen becomes available upon lowering of the ground water and results in large volume change and regional subsidence. (Levine-Frick 2001).

On blanket mire, the orientation of ditches relative to the slope is also significant. Traditional moor grips usually run across the slope at a shallow angle to the surface contours so that they intercept many flow-lines but water movement in the ditch itself is relatively slow. Ditches running perpendicular to the contours (i.e. straight down the slope), on the other hand, cross few natural flow-lines but the water they do collect can move along them at scouring velocities, especially in wet weather. Grieve (2001) points out that the incidence of soil erosion in Scotland can be related to the presence of such ditches.

There is a plentiful literature on peat erosion (e.g. Bower 1962a, b, Tallis 1964, 1985, Taylor 1983), much of it demonstrating that it generally occurs where the vegetation has been degraded to the extent that bare peat is exposed. This can result from overgrazing or because the vegetation has died as a result of drainage or fire.

In the absence of a functional acrotelm, excess water must often be discharged as so-called 'overland flow'. This sheet flow of water across a bog surface that lacks vegetation is physically dangerous because it can directly erode the peat. The low density of peat, particularly if it is dry, means that it can be readily lifted and transported downslope by concentrated water flow. Hulme and Blythe (1985) describe a particularly dramatic peat erosion event they witnessed during a thunderstorm in Shetland. Within a few minutes, the rainstorm caused such rapid flow of water through a series of erosion gullies that dried-out peat was lifted from the bottoms of the gullies. The peat became detached in large flat plates more than 25 cm across and several centimetres thick and was transported downslope by the rainwater torrent through the network of erosion gullies.

3.1.2 *Agriculture and Cashlaundrumlahan*

Grazing is not the dominant current land use on Cashlaundrumlahan but it is likely that it has been grazed in the past and that unafforested areas may still be used in this way. The open ground to the

north west of the summit shows no direct evidence of fire damage. A vegetation dominated by purple moor grass (*Molinia caerulea)* is often indicative of past burning but it is equally characteristic of highly oceanic western blanket mires. Coupled with the fact that the ground layer in this area has a reasonably continuous and vigorous Sphagnum bog moss carpet, the evidence seems to point to a lack of any serious direct damage by fire or trampling by grazing animals, at least in the recent past.

The fact that a reasonably intact pool system continued to survive on the hill summit until the coming of the forest plantations, and even now survives in somewhat modified form, would suggest that the blanket mire of Cashlaundrumlahan was in a reasonably natural state prior to afforestation. If it had been subject to significant burning and grazing, this pool system would almost certainly have degenerated into the type of erosion complex found on so many damaged blanket mires in northern Scotland (Lindsay et al. 1988).

3.2 *Forestry*

3.2.1 *General context*

Large-scale afforestation of peatlands was first made possible by the development of the Cuthbertson plough in the 1930s followed by the 'humpy' plough in the 1960s. Plantation forests expanded rapidly on blanket mire in Britain and Ireland during the 1970s.

The first stage of afforestation involves the construction of access roads so that the machinery for ploughing and other operations can be moved easily into the site. They must be capable of carrying the traffic required at all stages of the rotation, including the lorries used to transport harvested wood off the site. In the UK, forestry roads crossing peatland are usually laid on the mineral substratum after excavation of the full depth of both the acrotelm and the catotelm and are flanked by ditches that intercept and conduct away water draining from the cut peat faces so that it does not flood onto the road. The situation in Ireland is different in that most of the country's forestry is on bogland and techniques have been developed for constructing forestry roads without first removing the peat.

Where roads are laid directly onto peat (i.e. they have a peat subgrade), a range of engineering issues must be addressed, including subgrade drainage, materials consolidation, potential failure due to hydraulic pressure and bearing capacity.[2] Since peat deforms easily under mechanical pressure, roads with peat subgrades are inherently weak.[3] This means that they are vulnerable to excessive wear as a result of the flexing or deformation of the road that occurs as vehicle pass over it. The effect can be reduced by making the road thicker than it would need to be on a strong subgrade so that the weight of the vehicle is spread over a greater area. However, the design of these roads is complicated by the singular engineering properties of peat[4] which mean that both the bearing capacity and the stability of a peat road will vary with weather conditions and between time frames.

An investigation carried out in County Mayo in 1996 showed that a vehicle moving along a peat road caused it to flex by different amounts in winter and summer and that the amount of deformation also varied with the thickness of the peat substratum. This means that peat forestry roads in Ireland may generally be under-designed for the loads involved in all-season timber transportation and that certain measures to ensure their safe operational use are advisable. These include the imposition of limits on axle loadings, the use of low- or variable-pressure tyres and the introduction of vehicle routing restrictions that take into account seasonal variations in road strength. In particular, because deflection increases under warm, wet conditions, the summer is the most dangerous time for heavy traffic in terms of the degree of peat deformation (O'Mahony et al. 2000).

Once access for the machinery has been established, a widely-spaced series of 1.5 m deep drains is

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2 The California Bearing Ratio (CBR) for peat is two to four per cent, compared to a CBR value of 15 to 30 per cent for strong subgrades.

3 See www.highwaymaintenance.com.

4 In particular, the deformation modulus of peat decreases with water content and increases with the degree of decomposition.

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established across the whole of the area to be afforested. Between these drains, fertilizer is applied and a double-mouldboard plough is used to turn up continuous ridges of peat at between two and ten metres spacing from shallow (40 to 60 cm deep) furrows at a four metre spacing. In effect, the acrotelm is dissected into four metre strips, fertilized and buried. The plough furrows usually run perpendicular to the surface contours to promote drainage. The trees are planted on the upturned ridges between furrows so that their roots initially tend to develop preferentially along the length of the ridges rather than towards the furrows. As they grow, weed control and thinning are carried out and a second dose of fertiliser may be applied from the air at ten to fifteen years. The trees are harvested at around 40 years (Coillte 2004).

Forest planting is a surface impact whose initial effect is largely restricted to the acrotelm. If some of the trees fail to grow, it is quite common to see vigorous recovery of bog vegetation (and thus regeneration of the acrotelm) beneath the dying trees because the catotelm still provides the underlying hydrological conditions necessary to support the bog ecosystem. Lodgepole pine (*Pinus contorta*) appears to be more tolerant of these conditions than the other species commonly used in commercial conifer plantations (e.g. Sitka spruce, *Picea sitchensis*) because it requires less root aeration and so is able to root and grow in saturated peat. It is often used as a 'nurse' crop, its main function being to convert deep, wet peats into dry, mineralised peat soils and thus enable more commercially attractive timber species to be grown (Pyatt 1987).

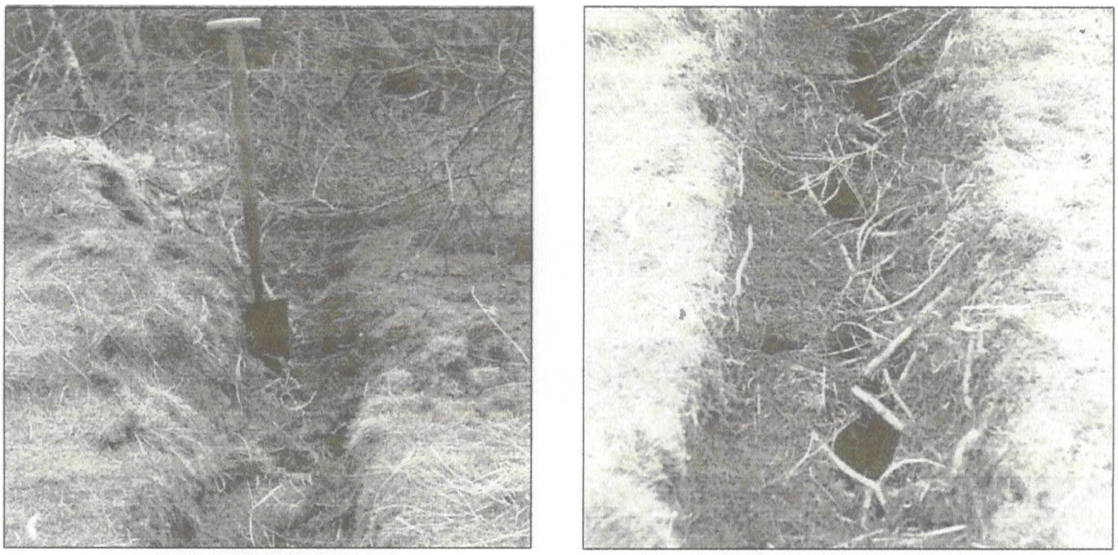
If lodgepole pine grows reasonably successfully, the trees start to bring about change on their own account and the effects of afforestation extend beyond the acrotelm into the catotelm, causing significant changes in the structure and hydrological functioning of the peat blanket. These changes have been researched in northern Scotland and the results widely reported in scientific and forestry journals since the late 1970s (e.g. Pyatt & Craven 1979, Pyatt 1987, 1990, 1993; Anderson et al. 1995; Anderson 2001).

The critical stage of the rotation is canopy closure which, for *P. contorta*, occurs ten to twenty years after planting. At this time, the ditches are already appreciably wider than they were at planting due to water loss and the consequent shrinkage of the adjacent peat. Now, shade-intolerant bog vegetation is replaced over a period of two to three years by forest floor communities and a litter layer consisting of dead needles develops. This enables fine tree roots to form mats across furrows and ditches, although these roots remain small and do not contribute appreciably to tree stability.

Canopy closure is accompanied by an increase in the capacity of the trees to intercept rainfall before it reaches the ground and in the rate at which they lose water by evapotranspiration. Consequently, in dry summer weather, water uptake by the trees replaces drainage as the main cause of peat drying and the water table falls well below the level of the furrow bottoms. As drying proceeds, peat shrinkage (section 2.3) leads to subsidence of the ground surface. Differences in ground level of up to 55 cm have been measured between plots of 20-year-old trees and the surrounding unplanted ground, most of the subsidence resulting from loss of water from the peat matrix.

Eventually, a point is reached where the peat's resistance to tearing is less than its resistance to subsidence, so it cracks. The ditches and furrows act as lines of weakness to the tensile stress produced by shrinkage of the intervening peat mass. The first cracks appear in summer along deep ditches, where the fibrous acrotelm has been removed and are followed a year or two later by similar cracks in furrows (plate 3.1). These early cracks can appear in very wet soft peat and are usually hidden by the litter and root mat.

Shrinkage cracks are commonly up to 15 cm wide and extend to a depth of 70 cm. Although they form in summer, they persist from year to year because peat shrinkage is irreversible. They do not, however, extend across the forestry rides. The water table lies below the cracked layer during the summer but rises into the cracks in winter. The ditches draining these cracks can lose half their depth within 15 to 20 years and, if they become blocked, the water stands in the cracks. However, once the reticulate network has developed, this can act as a drainage system. Dried peat has a limited ability

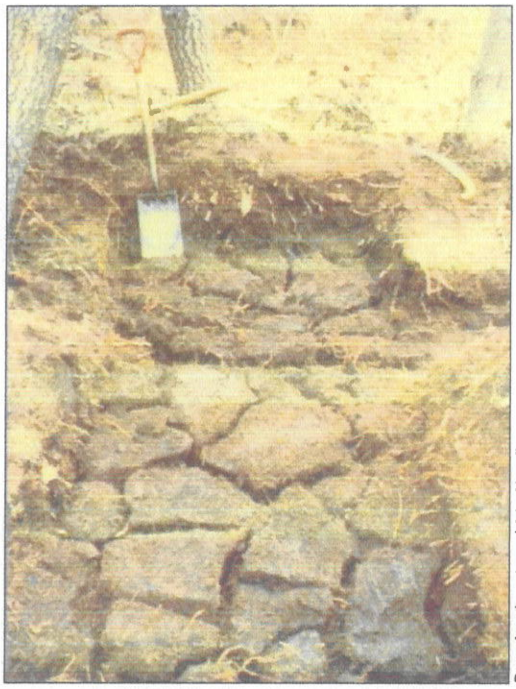


From Anderson (2001), reproduced courtesy of the Forestry Commission

Plate 3.1: Longitudinal crack in a plough furrow under mature forestry on deep peat in the north of Scotland, after removal of the litter layer.

to absorb moisture (section 2.3) and the cracks provide a bypass route so that eventually the water table beneath the trees is controlled principally by the cracks. At Braehour Forest, Caithness, plough furrows in peat less than one metre thick on a slope of five degrees cannot be effectively dammed with plastic piling because drainage continues to occur through the surrounding network of cracks.

Some years later, reticulate networks of cracks develop on the plough ridges directly beneath the trees. These develop fully within 20 years of planting on shallow and moderately deep peats and can penetrate to the substratum if the peat layer is less than one metre thick. These cracks are confined to the catotelm peat which has by now lost a great deal of water and is fairly dense. They do not open on the surface because the acrotelm is reinforced by strong structural tree roots but are invariably found when the surface 30 cm fibrous layer is removed (plate 3.2). However, the ditch and furrow cracks now become visible because they have grown so wide that the root and litter mat tears (fig 3.1).



Reproduced courtesy of John Hawell

Plate 3.2: Reticulate cracking in a plough ridge under mature forestry on deep peat in the north of Scotland, revealed by removing the surface fibrous layer.

A tree growing in wet, unstable peat will normally send out a wide mat of roots, partly to provide stability in the soft medium but also to maximise the root-surface area within the thin oxygenated surface zone of peat. However, small roots cannot grow across cracks. As the cracks steadily widen, only the roots that had already extended across them can continue to grow laterally. Most other roots are confined to the lines of the original planting ridges. The trees are therefore incapable of forming a wide stable fan that provides stability in all directions; the root systems of individual trees instead generally extend in the direction of the planting ridges but are extremely limited in the direction of the flanking furrows. This has been identified as a sylvicultural problem because the trees are stable in the direction of the plough lines but are markedly unstable to forces, such as wind, operating at right angles to the plough

lines. Peat cracking thus tends to make plantations prone to windthrow from certain directions. Indeed, windthrow is one of the principal risks to Irish forests, particularly after thinning.

3.2.2 *Forestry and Cashlaundrumlahan*

Cashlaundrumlahan was planted by the Irish forestry board, *Coillte Teoranta* (Coillte) during the 1970s. A large proportion of the hill was planted although some substantial areas remain between the various forest blocks (fig 3.2). The most frequent species is lodgepole pine but some Sitka spruce (*Picea sitchensis)* have also been planted, particularly as a second rotation crop after fire destroyed the first crop on the south-western slopes of the mountain (plate 3.3).

The network of existing, unmade forestry rides that connect with the access road for the turbary and the Cashlaundrumlahan radio mast (fig 3.3) was mapped in June 2002. These are not constructed roads but merely open corridors between the plantations for use as fire-breaks and access routes.

A number of areas across the site were examined for evidence of cracking in June 2004 and cracks were found in many places beneath 20 to 30 year old forest stands although, in most cases, their

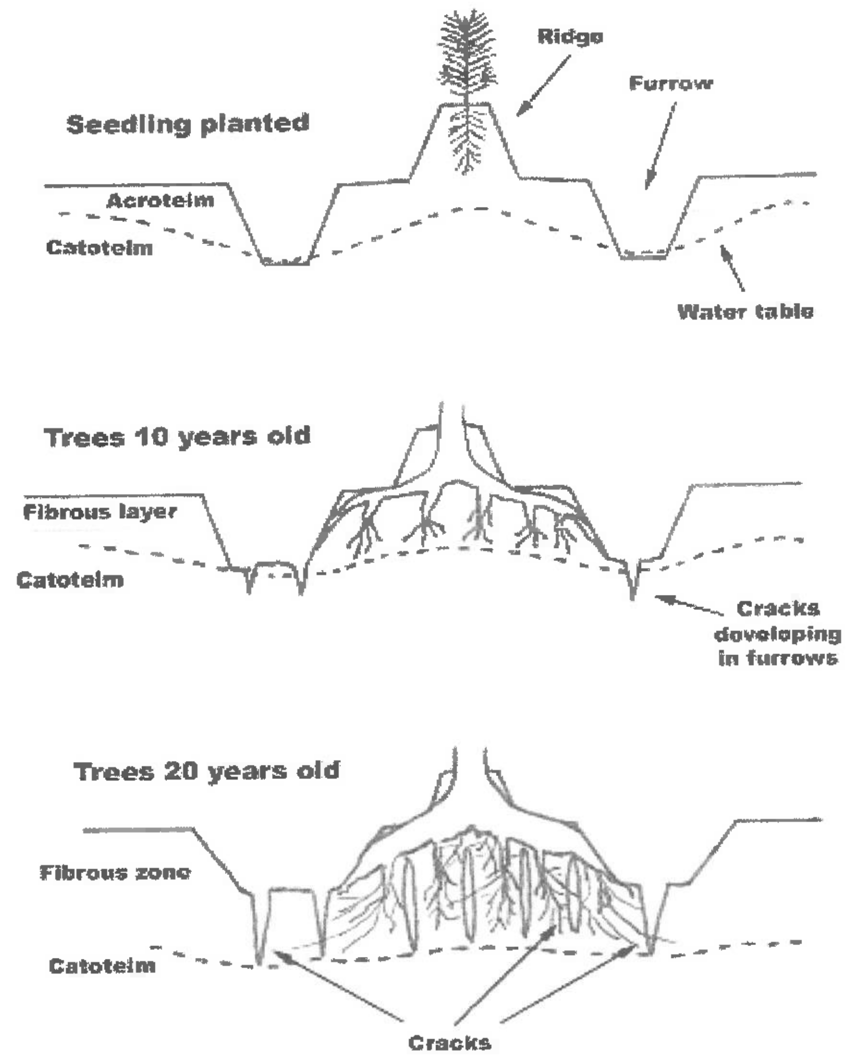


Figure 3.1: The sequence of drying and cracking that occurs in peat over a 20-year period beneath plantation forestry, particularly when the crop is lodgepole pine, *Pinus contorta* (adapted from Pyatt 1987).

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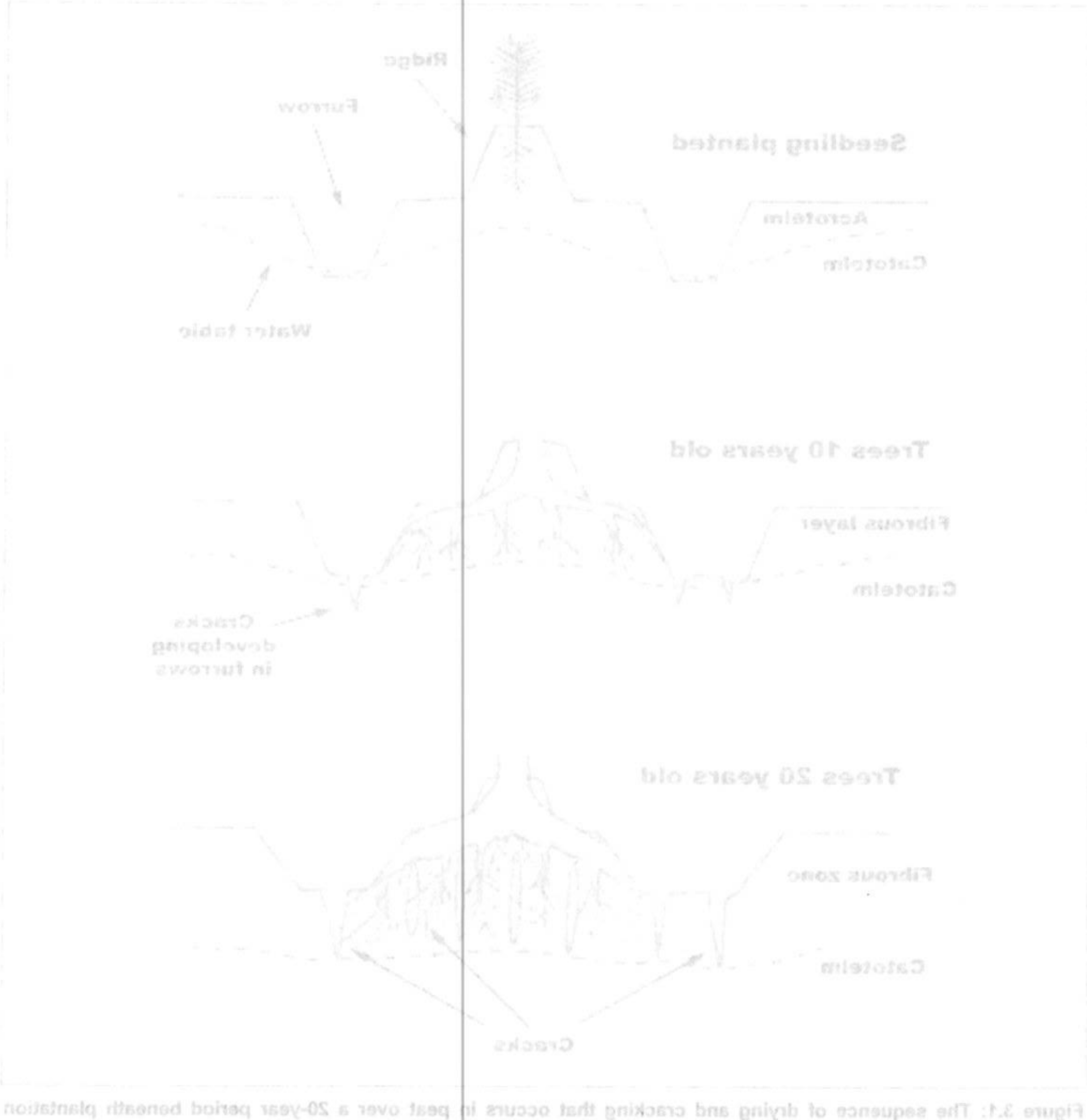

Figure 3.1: The sequence of drying and cracking that occurs in peat over a 20-year period beneath plantation forestry, particularly when the crop is lodgepole pine, *Pinus contorta* (adapted from Pyatt 1987).

Figure 3.2: The extent of forestry on Cashlaundrumlahan, indicated by green shading. The wind-farm boundary is indicated by the area for which peat thicknesses are given.

extent was not immediately obvious because they were covered by a surface layer of needles and small roots (plate 3.4). On removing this thin surface layer by hand, however, it was obvious that many of the ploughing furrows contained deep cracks running parallel with the furrows, which were generally oriented downslope. It was not possible in the time and with the resources available to determine whether a reticulate pattern of cracks had formed across the ridges but the deep and extensive nature of the plough-furrow cracks suggests that reticulate cracking may also be reasonably widespread if the sequence follows that set out by Pyatt (1987).

Almost the whole of a forestry rotation involves progressive loading of the peat surface. Peat solids in the catotelm of an undrained bog are close to being neutrally buoyant – they tend neither to sink nor to float up to the surface. As the bog is drained, the water table falls and the dewatered layers of

Plate 3.3: Spruce planted after the south-west part of the forest was destroyed by fire about 10 years ago. The ground here has thus been drained and planted twice: part of this area was involved in the October 2003 bog slide.

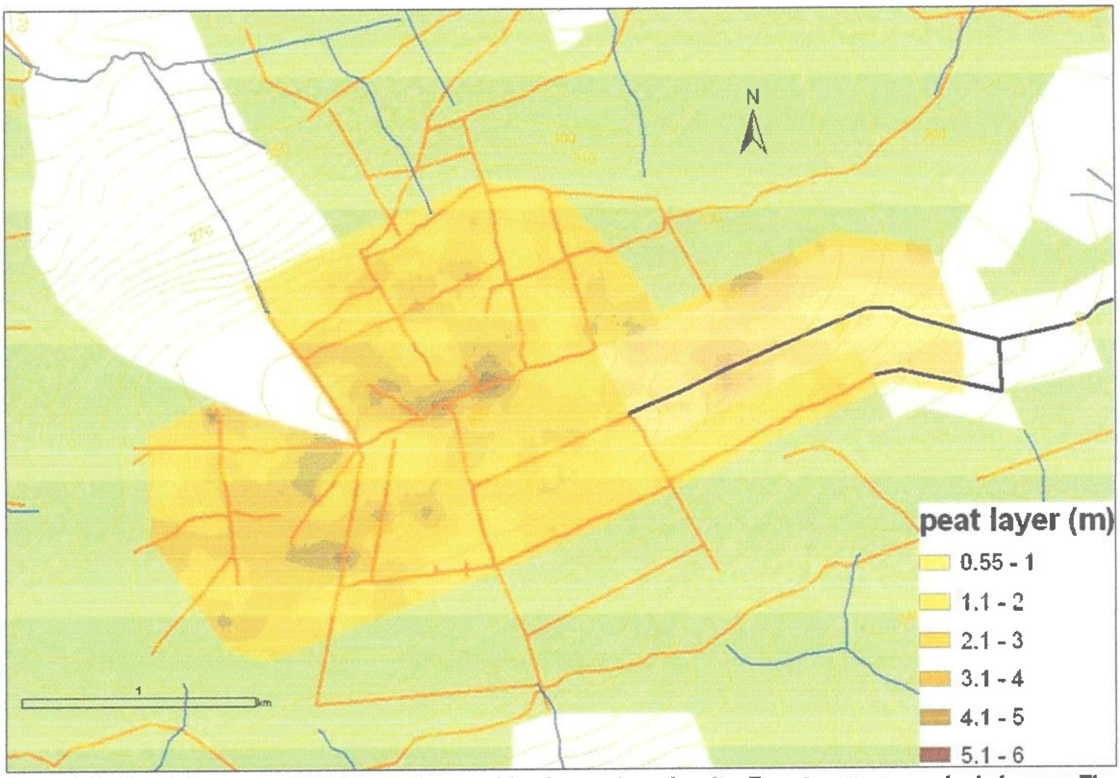

Figure 3.3: The turbary road (black) and forestry rides (orange) on the site. Forestry areas are shaded green. The wind-farm boundary is indicated by the area for which peat thicknesses are shown, streams are shown in blue.

peat gain weight because buoyant uplift is lost. Further loading of the surface occurs as the trees grow to maturity and their increasing weight is added to the existing overburden of drained peat. The final phase of the rotation is harvest, entailing the removal of the timber crop – and thereby also removing a substantial part of the load that has been accumulating on the peat. The water table may now rise because water is no longer being intercepted by, or removed through evapotranspiration from, the forest canopy. Some of the load resulting from the weight of drained peat may also thus be relieved as this peat is re-submerged and so re-gains buoyant support. Further physical and hydrological changes in the peat can thus be anticipated.

One possible effect is that the peat surface will rise or 'rebound' on unloading (Hobbs 1986). However, Schneebeli (1989) indicates that at least some of the reduction in peat permeability imposed by compression under the growing trees will persist after harvest, suggesting that rebound is incomplete. These are effects that have not yet been studied and recorded systematically because most first rotations of forestry on peat are only now approaching harvestable age.

Plate 3.4: A crack in the peat surface beneath forestry which is just visible despite the thick litter layer.

However, the potential for effects on the peat indicates a need for

Figure 3.3: The turbary road (black) and forestry rides (orange) on the site. Forestry areas are shaded green. The wind-farm boundary is indicated by the area for which peat thicknesses are shown, streams are shown in blue.

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However, the potential for effects on the peat indicates a need for particular vigilance when the forestry on Cashlaundrumlahan is harvested. Only those trees that were directly obstructing wind farm development work, such as road-building and turbine site excavation, have been felled so far (plate 3.5) and it seems possible that this patchy unloading could introduce significant local variations in peat condition across the site.

3.3 *Peat removal – turbary*

3.3.1 *General context*

The immediate effects of agriculture and forestry are felt by the surface layer, or acrotelm, of a bog. Longer-term effects on the catotelm may also be observed but direct physical disruption of the catotelm peat is relatively limited. This is not the case where peat is removed from the bog by peat or 'turf' cutting. This may involve only a small amount of peat removal from an individual 'peat bank'

Plates 3.5: Areas on Cashlaundrumlahan where forestry has been felled to make way for construction work.

but, where a community works collectively within a defined area, the result is an area of more extensive peat removal, generally referred to as a turbary. It involves cutting slabs of peat from the deeper part of the peat body then drying these slabs or 'turves' to use as domestic fuel. This exposes the catotelm directly to the atmosphere and also creates a sharp hydrological gradient in the peat because the shape of the catotelm has been radically altered.

Before the peat is cut, the surface layer of vegetation is removed. This is known in Shetland, for example, as 'flaying the peats'. After this, the remaining, lower part of the acrotelm is cut to produce quick-burning 'mossy peat', then the upper part of the catotelm (being of much more value as fuel and often termed 'black' or even 'blue' peat) is progressively cut away in turves from the face of a vertical peat face or bank. A drain may be cut to prevent water from ponding excessively at the base of the peat bank. When each year's crop of turves has been collected, a face of catotelm peat is left exposed directly to the atmosphere. What occurs next happens in four phases, described by Hobbs (1986) as:

- primary consolidation, in which water is squeezed from the large spaces in the peat matrix;
- shrinkage, where formerly wet material shrinks on exposure to air;
- secondary compression, caused by a slow rearrangement of fragments that permits micropore water to be squeezed out and which Hobbs describes as a major process in peat but one that is often overlooked;
- oxidative wastage, which Hobbs describes as almost unique to peat soils, resulting in conversion of the peat material to CO_2 and water.

The first three processes reduce the permeability of the peat along the face which tends to slow down further water losses from parts of the system that remain intact.

The process of peat extraction inevitably lowers the bog surface substantially and the new, lowered surface is generally (though not always) wetter than the uncut surface. Traditional practice also involves placing the 'flayed' turves of vegetation back down onto the new lowered surface, thereby encouraging it to knit together over time into something resembling bog vegetation. In this way, turbary operations tend not to generate significant areas of bare unprotected peat and are thus not normally associated with significant erosion. The immediate effect of a turbary is in the region of the raised cut face which undergoes slow but steady oxidative wastage. However, domestic turbaries are often poorly drained and minimally maintained so that water ponds in the cut areas and in adjacent drains, with the result that there is significant regeneration of peat-forming vegetation.

3.3.2 *Peat cutting and Cashlaundrumlahan*

A significant portion of the eastern end of the site consists of a large turbary containing several individual peat banks (fig 3.4). Many of these banks have not been cut for many years while some have evidently been used quite recently.

The pattern of cutting, enclosed within this one large turbary, differs in its impact from the more haphazard domestic peat banks found throughout much of Scotland. Typically, the Scottish banks are cut into a sloping hillside of peat to create an open-faced step that faces downhill. Although the flayed vegetation is then replaced on the lowered surface, the surface is generally able to drain freely downslope.

The enclosed and regularly-arranged turbary at Derrybrien consists of a series of parallel peat faces, each with a drain at the foot leading off downslope (because the turbary as a whole lies to the south of the summit ridge and thus slopes gently to the south). These drains then feed into a collecting drain at the foot of the turbary. However, because many peat faces have not been cut for several years and because the drains have not been renewed, drainage across a large proportion of the turbary is increasingly impeded and there are signs that a bog vegetation is regenerating (plate 3.6). Cracking, slumping and oxidative wastage can be expected within and around the margin of the turbary. In the absence of the forestry, the turbary may have given rise to drainage effects and erosion within the wet

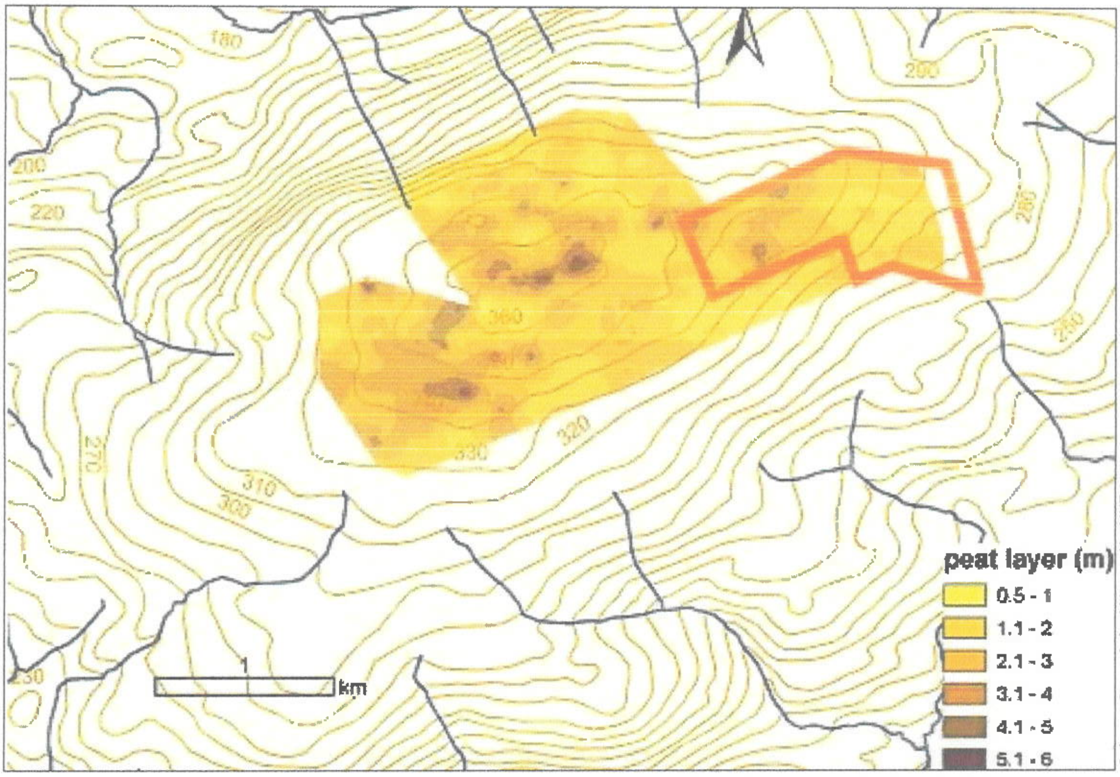

Figure 3.4: The extent of the turbary (indicated by the red boundary) on the Cashlaundrumlahan summit. The wind farm boundary is indicated by the area for which peat thicknesses are given.

blanket mire of the summit but, now the forestry has a much more profound impact, it masks the effect of the turbary.

3.4 *Slope stability*

One of the more spectacular results of human impact on a peatland is termed a bog burst or bog slide. This represents erosion of a spectacular type (which sometimes occurs on a dramatic scale) which occurs when large sections become detached from the main body of peat and collapse downslope like a snow avalanche, a mud-flow, or a volcanic lahar.

Slope stability is recognised as such a significant issue for certain types of development that the UK government has provided detailed policy planning guidance on the topic. This is discussed in more detail in section 7.6. For the moment, it is sufficient to observe that the guidance makes it clear that slope stability should form part of the initial assessment and the review of relevant factors that are part of the scoping stage.

In particular, scoping for stability should look at the predisposition to instability of the particular geology, slope, soil type, or any combination of these.

The published literature shows that blanket mire systems can be made less stable and more prone to slope instability as a result of various types of impact. The record shows that bog bursts have been associated with drainage, peat cracking, peat cutting and peat excavation and points to the need for both the scoping and impact assessment phases to consider very carefully the inherent potential of the Cashlaundrumlahan blanket mire for instability , given its existing pattern of impacts.

The possibility that further development of the type envisaged for Derrybrien might initiate such instability should be carefully examined. Section 4 is therefore devoted to the phenomenon of bog slides, bog bursts and instability in peat.

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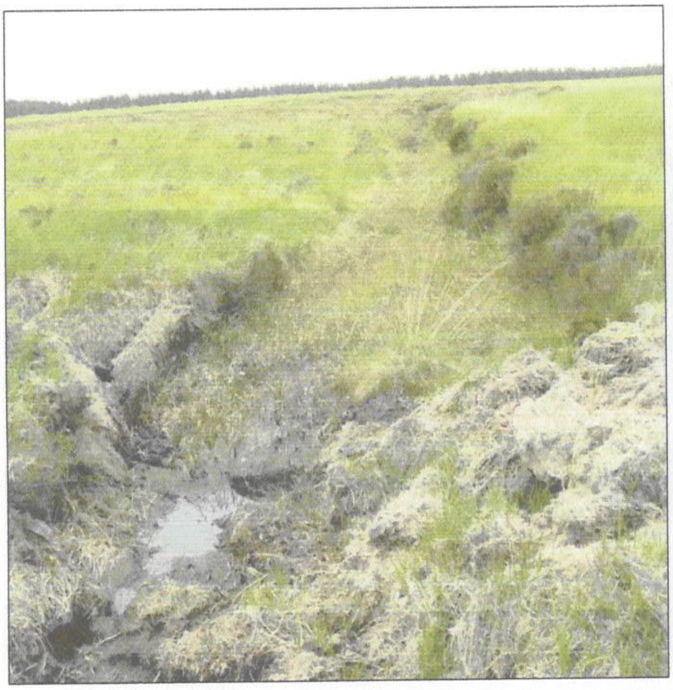

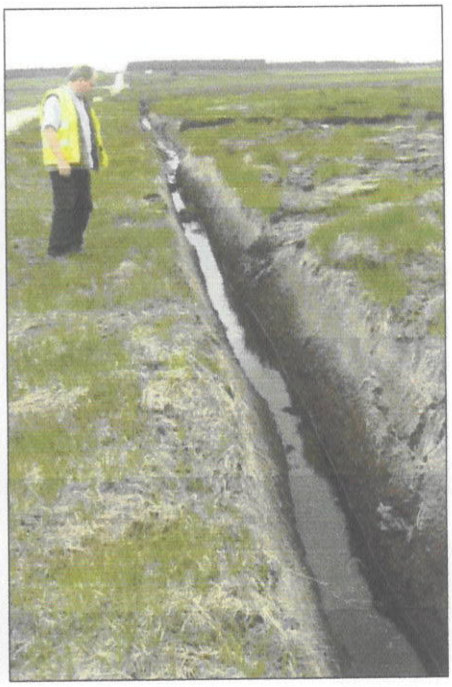

Plate 3.6: Turbary fields on the summit if the site showing (above) an old peat bank and (right) the downslope catchwater drainage system, re-excavated after peat slide in 2003).

Summary of Chapter 3

1 Agriculture on blanket bogs tends to lead to damage caused by trampling grazing stock, by burning to improve grazing and by drainage to improve grazing and remove hazards to stock.

2 These all tend to disrupt and destroy the living surface of Sphagnum bog moss that maintains the bog system as a biologically-active, self-sustaining ecosystem. Loss of this surface layer (and the protective acrotelm) tends to lead to peat loss through oxidation to CO_2 (oxidative wastage) and through the powerful forces of rainfall-induced erosion. There is little evidence of such damage on Cashlaundrumlahan.

3 Forestry causes major changes to the upper layers of peat. The living bog surface is lost through a combination of surface drainage and the interception of rain and light by the forest canopy. The trees dry out the surface layers of peat and cause increasingly deep cracking down into the catotelm. After 20 years the peat is deeply fissured. There is extensive forest plantation at Derrybrien and clear evidence of fissuring in the peat beneath the forest cover.

4 Peat cutting for fuel (turbary) leads to loss of both acrotelm and catotelm. The area from which peat is removed may become wetter because it becomes an area of water collection but the cut peat face is now subject to oxidative wastage. The turbary area at Cashlaundrumlahan forms an inclined but also enclosed basin. Many of the peat banks have not been used for some time and are now re-wetting. The major impacts of the turbary are enclosed within the turbary bounds.

5 There is potential for slope instability to develop on certain types of ground, particularly blanket peat, in association with impacts such as those described above.

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Chapter 4
Scoping – bog bursts and peat slides, a review of evidence

4.1 *Historical and geographical occurrence*

CATASTROPHIC MASS MOVEMENTS of peat have been recorded since the Middle Ages (Smith 1910). Some early accounts are tinged with fascination. Praeger, for example, (1897a) quotes one early source as follows:

> On the 7th day of June 1697, near Charleville, in the County of Limerick, in Ireland, a great Rumbling, or faint Noise was heard in the Earth, much like unto a Sound of Thunder near spent; for a little Space the Air was somewhat troubled with little Whisking Winds, seeming to meet contrary Ways: and soon after that, to the greater Terror and Affrightment of a great Number of Spectators, a more wonderful thing happened; for in a Bog stretching North and South, the Earth began to move . . . Leaving great Breaches behind it and spewings of Water that cast up noisome Vapours: And so it continues at present, to the great Wonderment of those that pass by, or come many miles to be Eye-witnesses of so strange a thing.

Sutcliffe (1899) gives a rather different description of a peat flow:

> Its solid, oncoming front was black and sticky: a man had time to count his sins thrice whilst the monster crept stealthily towards him. There are those about the moorside who remember seeing the spectacle; and they say that it seemed as if the whole moor top were turning over on its side and rolling downward.

The accompanying threat to life and property is clearly conveyed by accounts of the two nights in the late 19th Century when peat workings on the hill immediately behind the town of Stanley in the Falkland Islands gave way:

> Just after midnight on Friday the 29th November 1878, one of the inhabitants was awakened by the continuous barking of his dog and, on going out to investigate, discovered to his alarm that his house was surrounded by a moving mass of semi-liquid peat. The mass, which was several feet deep, was moving slowly down the hill at about four to five miles an hour . . . those houses affected were completely cut off from communication with the rest of the town until they had cut their way through the black mass. All communications between the east and west ends of the town were cut off except by boats.
>
> Despite attempts to stabilise the peat on the hill above the town, drainage remained a problem and on the night of 2nd June 1886 . . . A stream of half liquefied peat over a hundred yards in width and four or five feet deep flowed suddenly through the town into the harbour . . . The story is best told in the words of an eye witness, Mr Frederick E. Cobb, Manager of the Falkland Islands Company, in the report he sent home to his office in London:
>
> 'A horrible calamity occurred here last night, by which one life has been lost and great damage done to property. About 9 p.m. another peat slip took place similar to that of 1878 but more disastrous in its results. It started from the top of the hill and descended with immense force to the harbour and moved one house several yards and nearly overturned it, smashing all fences and walls that stood in its path, carried all outbuildings down to the water and found its way into the back premises of many buildings. The Church is half buried and the back wall cracked and bulged in, so as to be unsafe. A lad named Ratcliffe in trying to escape when the first rush came, was caught in some wire fencing and although several people had hold of him and nearly lost their lives in trying to rescue him, was horribly smothered and his body only recovered after daybreak this morning. There is a report that a man is missing supposed to be dead in a house that is nearly buried and a search is being made for him. Our

> store next the Church has suffered severely and I have at present as many men as I can gather trying to clear it but it is an impossible task. The liquid peat is nearly up to the ceiling in the kitchen and as fast as any is moved, more slides down from the hill. The inmates escaped just in time and took refuge in my house last night. In short Stanley is in a horrible plight and upside down and how it is to recover this winter I don't know.'.[1]

Similar catastrophes were occurring in Ireland at around the same time. In 1867, a whole townland in the Glancastle Hills in Erris slipped into the sea (Feehan and O'Donovan 1996) and a family of eight, their home and their livestock were carried away and buried by an extensive bog-burst in northeast Killarney on 28 December 1896 (Praeger 1937).

A century later, in 1983, three peat slips were recorded in northern England and southern Scotland within the space of eight days; two in the Pennines on 17 July (Carling 1984) and one in Roxburghshire on 25 July (Acreman 1991).

Peat slides were again in the news in 2003. On the morning of 19 September, the southern part of the Shetland mainland was cut off when the A970 road was blocked by peat sliding down the mountainside after a torrential downpour. In Ireland on the same night, intense localised rainfall triggered a series of forty slides on the Dooncarton and Barnachiulle Mountains near Pollothomas in County Mayo, damaging roads, private property and two graveyards (Tobin 2003, Trodd 2003).

An examination of available literature indicates that peat mass movements have been widely reported and have formed the subject of several scientific investigations. They appear to be particularly frequent in Ireland. Feldmeyer-Christie and Mulhauser (1994) comment that such events are very unusual in Switzerland but they occur comparatively frequently in Ireland and Scotland and Carling (1986) calculates an average recurrence interval of 6.3 years for peat mass movements in Northern Ireland as compared with 36 years for the English Pennines. Tables 4.1 and 4.2 summarise the locations and dates of peat mass movement events reported in the sources identified. Most of the records are from Britain and Ireland and more than 50 per cent are from Ireland or Northern Ireland.

Specifically for the Slieve Aughty Mountains, a sudden thaw precipitated mass movement of peat from Loughatorick North[2] into Ballinlough Lake, covering 100 acres of lowland with peat to a depth of one to seven feet on January 27 1890. The upper part of the bog is reported to have subsided by 10 to 15 feet (c. 3 to 5 m). A second event occurred in the southern part of the range (County Clare) in October 1934 and has been associated with high antecedent rainfall.

4.2 *Causes and mechanisms*

At least three types of catastrophic peat failure can be recognised. Classic bog bursts or bog flows involve 'rapid dewatering' – the emergence of well-humified amorphous peat as a fluid from a break in the bog surface, followed by settling of the residual peat in situ. Peat slides, on the other hand, involve failure at or below the peat/substratum interface leading to the translational sliding of detached rafts of surface vegetation together with the whole underlying peat profile. An intermediate type appears to result from failure within the peat layer itself, with detached rafts of surface vegetation being carried by the movement of a mass of liquid peat. The event at Slievenakilla (Ireland) described by Large (1991) appears to be one example of the latter (Kirkpatrick 1999). Dykes and Kirk (1991) propose the term bog slide to denote this intermediate category.

Substantial detail of the 1824 bog burst on Crow Hill (table 4.2) near Keighley in Yorkshire is available from records made by and associated with the Reverend Patrick Bronte (Tallis and Seaward 1999). The peat flow was 30 to 60 metres wide and five to six metres deep and continued for 10 to 15 miles. Substantial fish kills (1,270 kilograms of perch and trout taken from the River Aire at Horsforth) and disruption to the woollen industry were reported. Its point of origin was an almost-level bog which had become 'soft and swampy' over the preceding years, approximately 500m from the top of a steep gorge carrying a stream rising from the peat eastwards into the River Worth. The

1 *Falkland Islands Journal*, 1974

2 Loughatorick North is situated approximately eight km south east of Cashlaundrumlahan.

County	Location and date	References
IRELAND		
Clare	Slieve Aughty Mountains 1934	Mitchell (1935), AGEC (2004)
Cork	Bog of Farrtindoyle 1840	Lyons (undated)
Donegal	Meenacharvy Townland	Bishopp and Mitchell (1946)
Galway	Bog of Addergoole 1745	Lyons (undated)
	Joyce Country 1821	Lyons (undated)
	Dunmore 1873	Lyons (undated)
	Loughatorick North 1890	Lyons (undated)
	Slieve Aughty Mountains (Derrybrien) 2003	
Kerry	Knocknageeha / Gneevegullia, Killarney 1896	Cole (1897); Praeger (1937); Praeger (1897a); Sollas *et al.* (1897)
Leitrim	Slievenakilla 1980s	Alexander *et al.* (1985); Large (1991)
Limerick	Charleville 1697	Praeger (1897a)
	Castlegarde Bog 1708	Lyons (undated)
Longford	Bog of Rine 1809	Lyons (undated)
	Newtownforbes 1883	Feehan and O'Donovan (1996)
Mayo	Glancastle Hills, Erris 1867	Feehan and O'Donovan (1996)
	Glencullin	Delap *et al.* (1932)
	Owenmore River 1980s	Byrne (undated)
	Bellacorrick Forest	Hendrick (1990)
	Dooncarton Mountain 2003	Trodd (2003)
Offaly	Bog of Kilmaleady	Lyons (undated)
Roscommon	Castlereagh 1870	Lyons (undated)
	Castlereagh 1883	Kirkpatrick (1999); Feehan and O'Donovan (1996)
Sligo	Geevagh 1831	Lyons (undated)
	Straduff Townland	Alexander *et al.* (1985, 1986)
Tipperary	Dundrum 1788	Lyons (undated)
Wicklow	Powerscourt Mountain	Mitchell (1938); Delap and Mitchell (1939)
NORTHERN IRELAND		
Antrim	Fairloch Moss 1835	Lyons (undated)
	Slieve-An-Orra Hills	Tomlinson and Gardiner (1982)
	Skerry Hill	Wilson and Hegarty (1993)
Fermanagh	Carrowmaculla	Tomlinson (1981)
	Cuilcagh Mountain	Kirk (1999)

Table 4.1: Summary of the dates and locations of catastrophic peat failure events in Ireland and Northern Ireland as reported in the literature.

burst occurred at 18:00 hrs on 2 September 1824 during a violent localised thunderstorm. Two areas, the larger 200 to 300 metres across, slumped by four to six metres, their contents forming rivers of peat that united 100 metres downslope into a channel 12 metres wide and seven to eight metres deep which in turn discharged into the gorge. The event was accompanied by 'a deep, distant explosion' and 'a very considerable tremor of the neighbouring parts'. There was a second discharge of peat the following morning and four further 'eruptions' two days later, apparently in dry weather since there is an eye-witness account. This describes a new front of peat moving slowly down the channel, sometimes stopping, until it was discharged noisily into the gorge.

The peat failure at the Hermitage Valley in southern Scotland on 25 July 1983 (Acreman 1991)

County	Location and date	References
IRELAND		
Clare	Slieve Aughty Mountains 1934	Mitchell (1935), AGEC (2004)
Cork	Bog of Farrindoyle 1840	Lyons (undated)
Donegal	Meenacharvy Townland	Bishopp and Mitchell (1946)
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Kerry	Knocknageeha / Gneeveguilla, Killarney 1896	Cole (1897); Praeger (1897), Praeger (1897a); Sollas et al. (1897)
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The peat failure at the Hermitage Valley in southern Scotland on 25 July 1983 (Acreman 1991)

Area	Location and date	References
Scotland		
Shetland		Kirkpatrick (1999); Marter (2003)
Isle of Lewis		Bowes (1960)
Borders	Hermitage Valley	Acreman (1991)
Central	Blantyre Muir	Bragg *et al.* (1991)
England		
North York Moors	1938	Hemingway and Sledge (1943); Carling (1986)
Pennines	Crow Hill 1824	Bronte (1824a,b); Turner (1898); Sutcliffe (1899); Turner (1913); Barker (1994); Lock and Dixon (1965); Tallis and Seaward (1999)
	Meldon Hill 1870	Crisp *et al.* (1964)
	southern	Bower (1960)
	Langdon Beck 1961	Carling (1986)
	Teesdale 1963	Carling (1986)
	southern	Tallis (1985)
	no information	McCahon *et al.* (1987)
	Teesdale/Weardale 1983	Carling (1986)
Continental Europe		
Germany	Schšnberg, Oberbayern	Vidal (1966)
Switzerland	La Vraconnaz 1987	Feldmeyer-Christie and Mulhauser (1994); Feldmeyer-Christie (1995)
Canada		
British Columbia	Prince Rupert	Hungr and Evans (1985)
Southern Hemisphere		
Australia (Sydney)	Wingecarribee Swamp 1998	Proctor (1998)
sub-Antarctic	Maquarie Island	Selkirk (1996)
Falkland Islands	Stanley 1878 and 1886 Cape Meredith Hill (recent)	Anonymous (1974); Falkland Islands Journal (1974); Hungr and Evans (1985) Un-referenced newspaper article (A. Douse)

Table 4.2: Summary of dates and locations of catastrophic peat failure events other than in Ireland and Northern Ireland as reported in the literature.

involved the movement of sections of peat and vegetation that, during an intense localised storm at the end of a dry summer, parted intact from the edge of the peat blanket and slid towards the river below. Soil pipes were visible near the bases of failed peat faces and the failure plane appeared to be associated with an iron pan 20 cm below the peat/soil interface. The configuration of the edge of the peat suggested that such events occurred fairly regularly, effectively limiting the downslope development of peat cover. The mechanism invoked for this event is that stormwater was fed into the regolith beneath the peat via soil pipes above the slides and through cracks in the peat. Here, the water could infiltrate no further due to the presence of the iron pan and the resultant increase in pore-water pressures led to failure of the regolith. Carling (1986) reached a broadly similar conclusion from detailed investigation of the mechanisms of five translational peat slides that occurred on the flanks of Noon Hill at the Teesdale/Weardale watershed (northern England) in the afternoon of 17 July 1983. Once again, these occurred after thunderstorm rainfall of a very rare intensity (42-84 mm hr^{-1}) and return period (400-2500 years) following two dry months during which cracking of the surface peat had occurred. The mechanism proposed involves penetration of water to the base of the peat via cracks in association with overland flow, giving rise to super-charging of the pipe system and development of artesian pressure. Specifically, the cause of these slides was the crossing of an intrinsic stability threshold in the clay beneath the peat overburden which failed at the lower surface

Area	Location and date	References
Scotland		
Shetland		Kirkpatrick (1999); Marter (2003)
Isle of Lewis		Bowes (1960)
Borders	Hermitage Valley	Acreman (1991)
Central	Blantyre Muir	Bragg et al. (1991)
England		
North York Moors	1938	Hemingway and Sledge (1943); Carling (1986)
Pennines	Crow Hill 1824	Bronte (1824a,b); Turner (1898); Sutcliffe (1899); Turner (1913); Barker (1994), Lock and Dixon (1965); Tallis and Seaward (1999)
	Meldon Hill 1870	Crisp et al. (1964)
	southern	Bower (1960)
	Langdon Beck 1961	Carling (1986)
	Teesdale 1963	Carling (1986)
	southern	Tallis (1985)
	no information	McCahon et al. (1987)
	Teesdale/Weardale 1983	Carling (1986)
CONTINENTAL EUROPE		
Germany	Schönberg, Oberbayern	Vidal (1966)
Switzerland	La Vraconnaz 1987	Feldmeyer-Christie and Mulhauser (1994); Feldmeyer-Christie (1995)
CANADA		
British Columbia	Prince Rupert	Hungr and Evans (1985)
SOUTHERN HEMISPHERE		
Australia (Sydney)	Wingecarribee Swamp 1998	Proctor (1998)
sub-Antarctic	Macquarie Island	Selkirk (1996)
Falkland Islands	Stanley 1878 and 1886 Cape Meredith Hill (recent)	Anonymous (1974); Falkland Islands Journal (1974); Hungr and Evans (1985) Un-referenced newspaper article (A. Douse)

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The literature also indicates a number of associations with prior disturbance of the peatland:

- The two peat slips that engulfed Stanley in the Falkland Islands on 29 November 1878[3] and 2 June 1886 were attributed to the accumulation of water in old peat workings during unusually wet weather. The water eventually broke through uncut sections of bog on the brow of the hill behind the town (Anonymous 1974).
- Praeger (1897a) reports a number of bog bursts where the bog had given way along the face of a peat bank.
- Feehan and O' Donovan (1996) conclude that the probability of a failure event occurring is increased by the extent to which the surface has been damaged by burning or peat cutting.
- In 1987, a 15 ha section of the sloping bog of la Vraconnaz in the Swiss Jura Mountains which had been cut for fuel from the 18th Century until around 1945 slid downslope for at least 300 metres, breaking into rafts but leaving most of the trees standing upright (Feldmeyer-Christie and Mulhauser 1994). Although the immediate cause of this translational slide appears to have been the swelling of a spring at the upslope edge of the bog during two days of heavy rainfall following three weeks of drought, it seems likely that the area involved had been pre-disposed to sliding by the disturbance.
- Byrne (undated) includes in her account of Irish bog bursts a photograph of failure of peat by the Owenmore River in County Mayo that had been pre-drained for forestry (plate 4.1).

Some insight into possible mechanisms for these associations is also available. Carling (1986)

3 'The proximity of the settlers' peat banks (from where they obtained peat as a fuel for domestic stoves) to Stanley gave rise to large amounts of surface water runoff, which ran directly down the hill through central Stanley. This was not paid attention to and in late November 1878 the whole bank to the south of Stanley collapsed, running down in a three feet deep flow of liquid peat. This swamped the town, surrounding houses and actually cut off communication between east and west Stanley, apart from by boat. The next day a trench was cut at the back of the banks to cut the flow of water and it took a full week to clear the town of the residue' (Falklands Museum, undated).

Reproduced courtesy of Peter Foss

Plate 4.1: A bog burst in pre-drained forestry area in Co. Mayo blanket bog. Liquefied peat was discharged into the Owenmore River. Late 1980s.

Failure mechanism	Description	Hydrological control
Shear failure by loading	Hydrological loading – weight of absorbed water (rainfall, snowmelt) or snow	Absorption of water into the peat mass
	Increase in shear stress – hydrostatic pressure generated by water-filled cracks, ponds and lochs	Development of standing bodies of water in the peat
	Catastrophic loading – rapid increase in peat mass exceedance of shear strength	'Hydraulic mining' by heavy localised cloudbursts
Buoyancy effect	Generation of artesian pressures	Routing of water to base of peat (pipes, drains)
	Increase in interstitial pore-water pressure and reduction in cohesion	Transfer of surface water to base of peat through peat matrix
Liquefaction	Basal peat slurried by increased water content (exceedance of liquid limit)	Routing of water to base via watercourses, infiltration, surface routing
	Basal clay slurried by organic acid dispersal (passing of liquid limit)	Long-term peat/clay interface chemical interaction
	General increase in basal moisture content by routing of artificial drainage	Downslope drainage impedance by blocked drains; enhanced upslope drainage by open drains and cuts
Surface rupture	Swelling of basal peat leading to rupture of the drier surface	Increase in water availability to basal peat
	Relative swelling of basal peat by contraction of surface during drought	Reduction in surface water content
	Long-term depth creep inducing surface rupture or shear failure	Development of seepage pressures
Margin rupture	Removal of underlying support by stream action – release of basal peat	External hydrological processes
	Removal of underlying support by peat cutting	Anthropogenic cause

Table 4.3: Some possible failure mechanisms triggering peat slides

observed the capture of artificial drains by perennial peat pipes, whose catchment areas are thus substantially increased, and suggested that this phenomenon might substantially reduce peat stability where drains run transverse to the slope and where they cross natural drainage lines or flushes. Kirk (1999) suggests that re-establishment of a high water table in cutover blanket bog on Cuilcagh Mountain in County Fermanagh (Northern Ireland) may lead to a rise in pore water pressure and changes in a variety of other stability factors, reducing the shear strength of the peat and increasing the risk of slope failure. Morphological evidence at one failure location with only 0.7 metres of peat indicated a distinct sequence of events, beginning with the failure of a small segment of slope above a degraded transverse drainage ditch which had been cut less than 10 years previously. The failure surface was not in the peat but at or near the base of an underlying 0.5 metre clay layer which contained small soil pipes. Modelling indicated that both the soil pipes and the drain were required to reduce stability sufficiently to initiate failure, leading to the conclusion that the cutting of the drain and the hydrological impacts of its subsequent degradation were the ultimate cause of the peat slide (Dykes and Kirk 2001).

Two accounts of other similar incidents associate peat failures with specific drainage activities. At Blantyre Muir in central Scotland, the collapse of a section of mire above a truncated bog edge left by adjacent open-cast mining operations appeared to be centred on a drain running perpendicular to

the cut peat face (Bragg et al. 1991) and it is possible that a water pump was being used in the vicinity. Wingecarribee Swamp, a spring-fed fen largely dominated by Restionaceae near Sydney, Australia, suffered spectacular failure following heavy rainfall in August 1998. It originated on a slope of 0.15 per cent at the upstream edge of a peat-mining operation in which peat slurry was being pumped out of a dredge pool some 30 ha in area. The unsupported peat face at the head of the dredge pool sheared and gave way and some four million cubic metres of peat collapsed progressively 'like a pile of dominoes or unzipping a zip fastener'. This appears to fall into the intermediate 'bog slide' category, with the middle part of the peat column behaving as a semi-fluid material (Proctor 1998).

In a current review, Warburton et al. (2004) report associations of peat mass movements in the north Pennines with summer thunderstorms and pre-existing drainage features and identify four common characteristics of peat mass-movement sites:

- a peat layer overlying an impervious or very low permeability clay or mineral base (hydrological discontinuity);
- a convex slope or a slope with a break of slope at its head;
- proximity to local drainage from seepage, groundwater flow, flushes, pipes or streams;
- connectivity between surface drainage and the peat/impervious interface.

However, they consider that the exact mechanisms of failure are not fully understood and that key hydrological questions remain unanswered. They suggest five possible failure mechanisms, summarised in table 4.3.

Whatever the particular mechanisms in any given case, one of the common threads that runs through most of the literature concerned with bog bursts and bog slides is that the incidents are generally associated with some form of human disturbance, particularly disturbance that has disrupted the integrity of the acrotelm in some way. The mechanics of a slip may involve collapse or rupture within the acrotelm or even in the mineral base beneath the peat but the weak spot which acts as the trigger for the event is more often than not to be found in damage to the thin surface layer. It may be thin but the acrotelm plays a much more important role in maintaining peatland stability than is perhaps generally realised.

Summary of Chapter 4

1. When peatland ecosystems undergo catastrophic collapse, releasing much of the liquid core of the catotelm in a dramatic flow, this is known as a bog burst.
2. When a mass of peat slides dramatically down a slope in the style of an avalanche, it is referred to as a peat slide if the failure occurs in the underlying mineral soil and a bog slide if the failure occurs within the body of the peat.
3. Bog bursts, peat slides and bog slides are widespread and well-documented phenomena. There are records of such occurrences from as far back as the Middle Ages and they have been recorded from as far away as the Falkland Islands There are many documented cases for Ireland and the UK.
4. Heavy and prolonged rainfall is often associated with such events. In other cases there may be a link to ponding and surface-water movement through the use of pumps. In either case, localised ponding and rapid surface water movement appear to be common factors.
5. In most cases, the origination point of the bog burst/slide is found to be a feature resulting from human impact.
6. The peat may travel several kilometres, particularly if it enters a watercourse.
7. Several different types of failure have been recognised – shear failure through loading, buoyancy effect, liquefaction, surface rupture and margin rupture.

Chapter 5
Assessing potential impacts

UNDER NORMAL CIRCUMSTANCES an EIA is concerned only with impacts that may occur at some time in the future as a result of a proposed development. In the case of Derrybrien, circumstances are different because some work had already been undertaken prior to the authors' site visit in June 2004 and, although this section is nominally about proposed and potential effects, it is possible to say something about the methods actually used.

This provides the rather unusual benefit (for an EIA) of 20:20 hindsight and brings with it the suggestion that the present authors have an unfair advantage over the authors of the original EIA because factors which are now plainly evident could not have been foreseen before work started. However, while that is valid as a point of general principle, the issues discussed in this section arise from the first principles of understanding of peatland ecosystems and the existing evidence of associated impacts obtained for a wide range of peatland sites in Ireland and elsewhere.

The scoping section of the present report does not therefore differ significantly from what would have been said had it been written prior to any development. The issues raised here about on-site practices would have been raised in any case on the basis of practices on sites elsewhere in Europe.

The final outcome of the three-year planning process that preceded the start of construction (section 7.1) was that there would be 71 turbines arranged at approximately 200-metre centres across the summit of Cashlaundrumlahan. The layout of the turbines is shown in fig 5.1.

Construction began on 2 July 2003 but was halted after four months due to the landslide of 16 October. Thereafter, only maintenance and safety operations had been carried out by the time of the authors' site visit on 8 June 2004, when most of the site photographs in this report were taken.

5.1 *Road construction*

5.1.1 *Road proposals*

The need for vehicular access for installation of turbines and subsequent maintenance means that a network of roads was needed. Since the existing forest rides are merely unplanted corridors between the plantations and are not surfaced, vehicular access needed be upgraded to something capable of carrying wind farm traffic. The developers therefore proposed to construct a number of new road sections. Their relationship with the existing turbary road and the various forest rides is shown in fig 5.2. Unlike the turbary road, these new roads were intended to float on the surface of the peat. Each 'floating' roadway consists of a base raft of brushwood and felled trees, covered by a layer of geotextile and surfaced with aggregate to a total thickness of c. 1.5 metres (AGEC 2004. See also plate 5.1). The aggregate would be obtained from a 'borrow pit' on site. The perceived advantages of the floating design were cost and the fact that no drainage of the peat was necessary (Saorgus Energy Ltd. 1997, 2000). The possible disadvantage of the method was that it is largely untried on this site.

5.1.2 *Floating 'undrained' roads on peat*

Roads supported by geotextile matting have been used in recent years at a variety of locations within

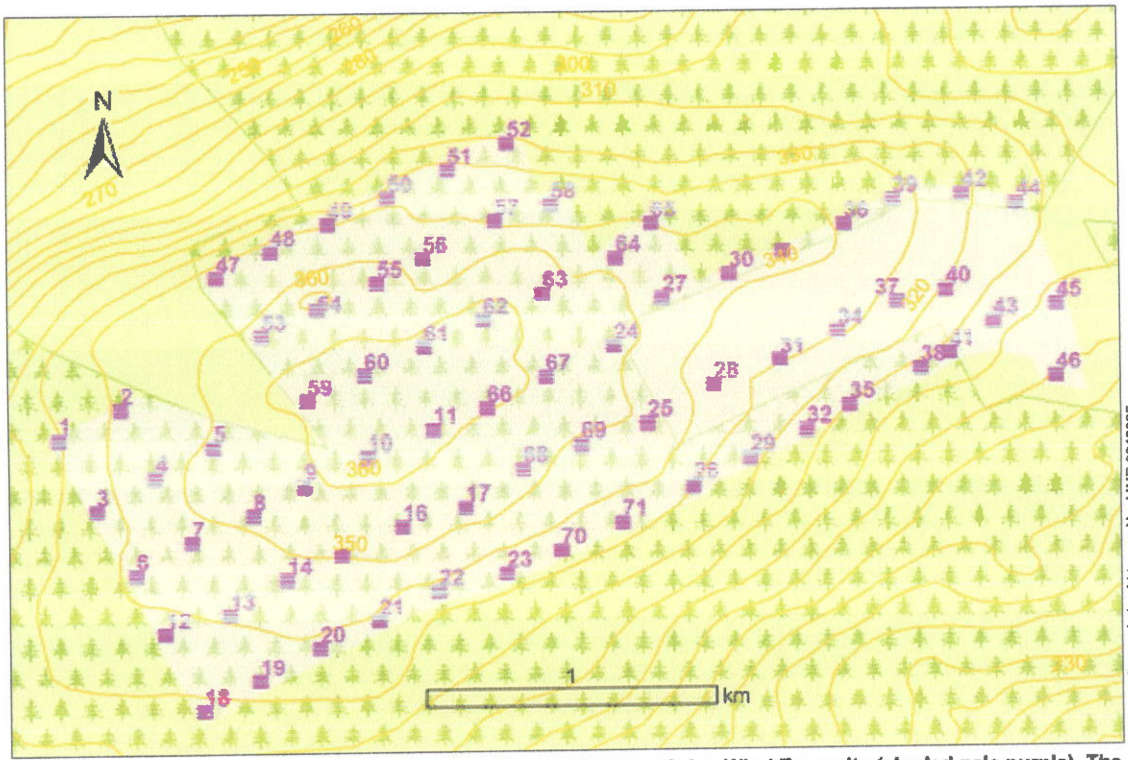

Figure 5.1: Proposed layout of turbines (violet squares) at the Derrybrien Wind Farm site (shaded pale purple). The numbering of the turbines reflects the three planning phases: Phase 1 (turbines 1-23 at the western side of the site), Phase 2 (turbines 24-46 to the east) and Phase 3 (turbines 47-71 in the centre).

Europe to limit surface damage when temporary access has been required for tracked machinery across peatlands. However, these roads have been required for only a few weeks and have been rolled up and removed from the site after use. The wind farm roads would not be temporary since, once the turbines have been installed, it is necessary to maintain the roads in such a condition that heavy lifting gear can be brought in at any time. It cannot be predicted when a rotor blade might break or a new component might be required in a nacelle. Maintenance cannot wait while the road is re-instated.

At first sight this approach to road-building might appear to be compatible with the eco-hydrology of the bog since the timber raft is designed to float within the acrotelm, the spaces between the piled tree trunks and branches providing a series of large interconnected spaces that would allow water to move freely beneath the road.

Even though many of the roads would cross natural seepage flow-lines, the intention was that the hydrological functioning of the peat blanket described in section 2 would not be disrupted.

As far back as Neolithic times, trackways were being 'floated' across peat bogs (Cox, Straker and Taylor 1995) and the principle was used by Stephenson when taking the Liverpool-Manchester railway across the great

Plate 5.1: Floating road at Derrybrien Wind Farm.

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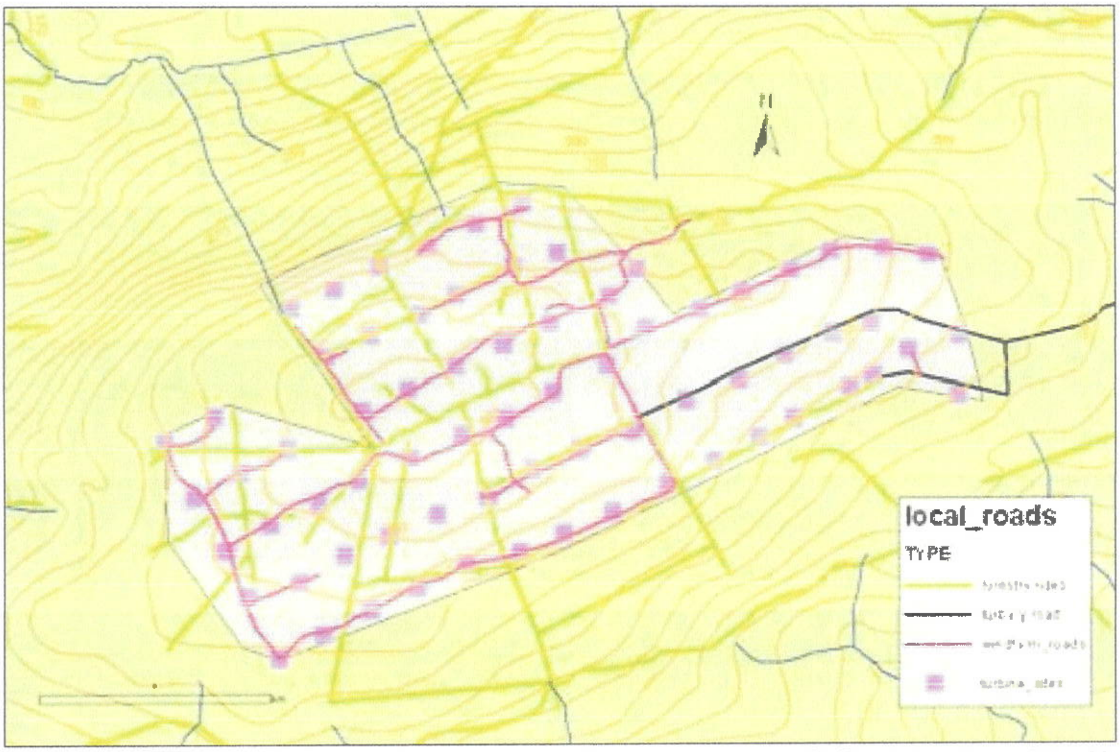

Figure 5.2: Arrangement of existing turbary road (black) and forest rides (green) on the Derrybrien site together with the new floating roads (purple) built before October 2003. (New roads according to AGEC 2004.) Some of the turbine sites (lilac squares) are not yet served by access roads so that a need for further road construction can be anticipated. Stream-courses are shown in blue, contours in pale brown.

Chat Moss (Simmons 1995). However, in the practical installation of these modern-era roads, it has proved necessary to add a vital factor to the construction method – drainage – for reasons explained below.

There are many examples of 'floating' roads or railways from Britain and Ireland and plate 5.2 shows one on Lenzie Moss in Scotland. Here, a railway line that was floated across the bog in the 19th century now lies at the base of a three-metre cutting. It is evident that, in practice, even when a road or railway is constructed using the floating principle, it very rarely truly floats on the mire surface but tends instead to sink deeper and deeper into the peat, in some cases very obviously so, as at Lenzie Moss. Here it has sunk to a much greater depth than can be explained by simple waterlogging of the underlying raft.

This may at first seem surprising, since peat is essentially a liquid (section 2.3) and the roadway should continue to float provided sufficient buoyancy has been provided. After all, a soundly-made

Plate 5.2: Railway line 'floated' across Lenzie Moss during the 19th Century. The track has now sunk by about three metres and the bog is clearly divided into two sections. Note also the lines of taller trees flanking the track, reflecting the associated drainage.

wooden boat does not sink simply because it has been floating on the water for some time. The floating-road design becomes less attractive, however, when we realise that a timber raft will eventually become waterlogged and that wet wood is negatively buoyant. Even a soundly-made boat requires constant maintenance if the timbers are not to become waterlogged. If they do, the boat will sink just like any other waterlogged timber. A road built to a design based on floating timber cannot be expected to float for very long. Once it ceases to float, the wood and the aggregate on top of it will begin to sink into and/or compress the peat beneath.

In fact a road (and its flotation layer) laid across a mire surface does not lie on the surface of the liquid but on the surface of the acrotelm, which is not continuously saturated. Such a road therefore tends progressively to crush the surface of the acrotelm beneath it when the water table falls. Eventually it comes to settle at the base of the acrotelm, beneath the range of water table fluctuation. The timber becomes progressively waterlogged, sinking further into the upper layers of the catotelm. In times of high rainfall, water from the acrotelm begins to drain onto the road surface because the surface is lower than that of the bog surface around it. The road (or railway) thus becomes more liable to surface flooding and in turn becomes increasingly unusable.

5.1.3 *Floating roads and slopes*

There are additional complications associated with floating roads wherever the road lies on a slope. Where they run parallel with the contours or at gentle angles to them, they tend to pond water along their upslope side while, at the same time, preventing this water from reaching parts of the bog downslope from the road. This ponded water poses a threat because it brings a significant weight to bear on the upslope side of the road and creates a pressure differential tending to push the road out of alignment. In wet weather, it may also overflow across the road surface, especially if this has sunk into the peat to any degree, leading to further disruption of the roadway surface and making it even les suitable for traffic.

The supply of water to the bog downslope is also modified. Instead of receiving natural seepage from upslope, this part of the system is now generally deprived of water in the same way as peatland that lies downslope of a ditch but there will be occasions when it is suddenly inundated by ponded water spilling over the road, creating the type of flow conditions that induce erosion (section 3.1.1).

5.1.4 *The need for drainage*

To avoid problems of localised ponding, it is almost invariably necessary to dig ditches running parallel to the road on one or both sides, with the road surface cambered to shed water towards these ditches. This introduces problems of drying, shrinkage and wastage associated with the drainage of peat adjacent to ditches (sections 2, 3). The oxidative wastage caused by continual cleaning out and re-cutting of the ditches (thereby continually exposing catotelm peat to the atmosphere) is the principal reason that many formerly-floating routes across bogs now lie firmly on the underlying substratum.

The need to maintain the turbines means that there is also a need to maintain the drainage for the lifetime of the wind farm and the de-commissioning process. No detailed design criteria have been provided for the peat roads at Derrybrien. However, experience with wind farms in Britain leads the present authors to conclude that floating roads cannot provide the environmentally-friendly solution proposed in the EIA for Derrybrien.

5.1.5 *Roads and water management*

Establishing a drainage system may provide an operational (though not an environmental) solution to localised ponding but it must be designed and set out appropriately in relation both to the natural pattern of drainage and to the arrangement of roads across the site. Where the natural drainage pattern crosses roadways, culverts can be placed at appropriate locations beneath the road but the water flowing from these culverts must be fed into an effective drainage system capable of carrying

the water away safely. If instead the water is allowed to flow unchecked and uncontrolled onto the peat surface, it will cause significant peatland erosion from the mouth of the culvert downslope in an ever-expanding fan. It also has the potential to cause more dramatic effects if the peat is already somewhat destabilised.

Once the need for drainage is identified, it must also be acknowledged that it is only as good as its weakest point. A system that moves water from one part of the site simply to collect in another merely transfers the problem rather than solves it. To minimise the possibility of instability due to from localised ponding, the developer is faced with a substantial integrated drainage programme. However, such a programme may give rise to other forms of hydrological instability, particularly if the site is already predisposed to instability.

There are significant dangers in attempting instead to disperse water over the surface of the peat. Water emerging from a drain or culvert during heavy rain does so with a force quite unlike that normally experienced on a bog with an intact acrotelm. A living bog surface cannot withstand such shearing forces and the protective plant cover is quickly destroyed. Once this acrotelm layer has been removed, or if the site was already damaged and lacked a protective vegetation cover, the unprotected catotelm becomes subject to strong scouring and erosive forces, much as is seen in the extensive eroding blanket mires of the Peak District in England (Tallis 1964, 1985, 1987). Such erosion complexes can begin from a single location but in time can spread across an entire bogland system.

Such release of water may also trigger a more dramatic set of events if it is channelled onto areas of peat already predisposed to instability – with, say, extensive cracking as a result of drainage, for example. In such cases, there is a danger that bog slides may be initiated.

The developer is faced with having to weigh up several sometimes sharply opposing factors, including:

- landform and natural drainage patterns;
- road layout;
- required drainage layout;
- oxidation of drained peat;
- current stability of peat cover;
- possible subsequent stability of peat cover;
- influences on downstream water quality;
- changes in streamflow regime;
- influence on downstream ecology.

5.2 *Excavation of turbine bases*

5.2.1 *Size of turbine bases*

Once access to a turbine site is established, its foundation, whose purpose is to support the turbine in a vertical position, can be installed. It must be sufficiently massive to make the structure 'bottom-heavy', so that it remains vertical even when the wind is pushing it sideways, and it must spread the weight so that the turbine does not sink into the ground. At Derrybrien, the method proposed is that peat is excavated down to 'competent' (solid) bedrock and a fifteen-metre square concrete pad or foundation block is constructed on this. A tubular steel can cast into the concrete forms the lowermost section of the tower.

The thickness of peat varies widely across the site so that, whilst some of the turbine excavations need to be barely one metre deep, others are associated with considerable thicknesses of peat and need to be much deeper. The surface area required for each excavation represents the area of the concrete base pad plus a volume of rock overburden introduced once the concrete of the base-pad has set. This backfill is piled over and around the pad to provide sufficient weight to ensure that it remains anchored to the ground when the turbine is in place and subject to its maximum wind load.

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5.2.1 Size of turbine bases

Once access to a turbine site is established, its foundation, whose purpose is to support the turbine in a vertical position, can be installed. It must be sufficiently massive to make the structure 'bottom-heavy', so that it remains vertical even when the wind is pushing it sideways, and it must spread the weight so that the turbine does not sink into the ground. At Derrybrien, the method proposed is that peat is excavated down to 'competent' (solid) bedrock and a fifteen-metre square concrete pad or foundation block is constructed on this. A tubular steel can cast into the concrete forms the lowermost section of the tower.

The thickness of peat varies widely across the site so that, whilst some of the turbine excavations need to be barely one metre deep, others are associated with considerable thicknesses of peat and need to be much deeper. The surface area required for each excavation represents the area of the concrete base pad plus a volume of rock overburden introduced once the concrete of the base-pad has set. This backfill is piled over and around the pad to provide sufficient weight to ensure that it remains anchored to the ground when the turbine is in place and subject to its maximum wind load

The backfilled area also provides a permanent hard-standing for construction vehicles, particularly in areas of deep peat. A heavy crane is required to erect the tower and attach the nacelle and rotor. The excavation must be big enough to provide adequate hard-standing for this and for maintenance.

5.2.2 *Turbine bases and drainage*

Turbine excavations raise a number of drainage-related issues. A hole dug through peat down to bedrock represents an area of drainage as long as the cut peat face remains exposed to the atmosphere. An enclosed hole without an outflow will tend slowly to fill with water seeping from both the acrotelm and the catotelm (and from direct rainfall) until the water in the hole is level with that in the surrounding peat.

Construction of the turbines is hampered by this ponded water, particularly if it accumulates to any depth. Wherever ponding is a problem, there is an associated requirement for drainage. This is achieved either through digging outflows from the excavation or by using a pump. Both techniques come with all the hazards already discussed in relation to road construction and an impact assessment would need to consider this carefully.

If the hole is in flat ground and it is not drained, once it is full of water it will largely cease to act as a drain on the surrounding peat (fig 5.3a). If, on the other hand, the hole is dug in sloping ground, the water table in the hole can only rise to the level of the lower lip of the hole and the upslope face of the hole, remaining above the water level, continues to suffer drainage (fig 5.3b). The larger the surface area of the hole for a given gradient, the larger will be the difference in height between the lower and upper lip of the excavation. As discussed above, the area of each excavation is quite substantial because it must include hard-standing for construction and maintenance. It is likely that at least the upslope face of the excavated peat will in such cases remain dry and exposed even if the excavation is permitted to fill completely with water.

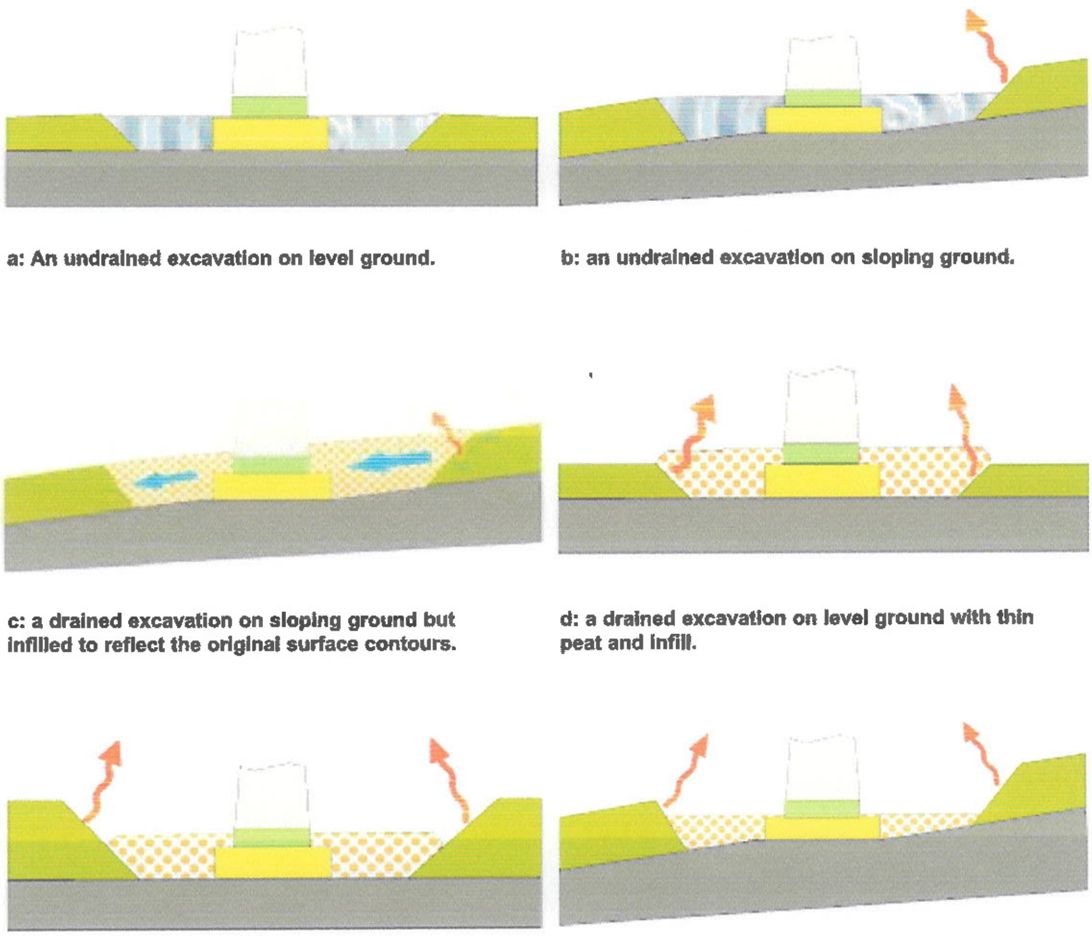
A partial solution involves backfilling the excavation to the former surface contours with original sub-soil and covering this with a layer of peat that reflects as far as possible the original peat thickness. This is not as simple as it might seem. Neither the replacement subsoil nor the peat will possess their original structural integrity and, without a well-knit mat of bog vegetation covering everything, the peat tends to be eroded by rain. Infilling an excavation with anything other than the original type of sub-soil and peat will not produce the same hydrological characteristics as before. It does not provide a replacement for the peat and sub-soil because the overburden contains relatively large spaces between the rock fragments through which water can flow much more easily than it can through peat.

If the partially or wholly-infilled excavation also has a drainage system to prevent this infill (and the turbine base) from becoming inundated, then the whole mass of overburden will remain freely-draining and the peat faces of the excavation margins will continue to suffer water loss even though they may not be so obviously exposed to the atmosphere (fig 5.3c).

In practice, such comprehensive, contoured backfilling is most unlikely because the site managers require hard-standing for construction and maintenance vehicles. A turbine base is likely to be a reasonably wide hole with drainage and rock infill brought from the borrow pit to give added weight and form a flat surface around the tower. If the ground is level and the peat shallow, the infill may indeed cover the cut peat face but even this will not prevent drying of the peat if the excavation is drained (fig 5.3d). If the basin is flat but surrounded by deep peat and is also drained, then the exposed peat faces will be extensive (fig 5.3e). The most likely scenario is fig 5.3f, where the ground surface slopes, the excavation is drained and the backfill covers only a small proportion of the exposed peat faces.

5.2.3 *Turbine bases and the water table – buoyancy*

The design of the foundation for the turbine base is crucial and may vary from turbine to turbine across a single wind farm if, for example, there are local differences in ground strength. Of particular significance, given that most bases are set into ground formerly covered with peat, is the relationship



a: An undrained excavation on level ground.

b: an undrained excavation on sloping ground.

c: a drained excavation on sloping ground but infilled to reflect the original surface contours.

d: a drained excavation on level ground with thin peat and infill.

e: a drained excavation on level ground with deep peat and infill.

f: a drained excavation on sloping ground with infill.

Figure 5.3: Turbine-base construction. The illustrations represent a cross-section of an excavation and construction for a wind-turbine tower. The bedrock is dark grey, the peat thickness is green, water is blue and rock infill is red spots. The yellow is the concrete base for the turbine, the turquoise is the turbine base 'can' and the light grey is the turbine tower. The red wavy arrows represent loss of CO_2 and water from the peat, the blue arrows represent water movement.

between the base and the water table. If the base is installed below the water table and is thus submerged in use, its effective mass will be reduced by a buoyancy effect. This will tend to reduce the effective downward anchoring force, adding a potential instability into the construction. This explains in part why developers normally ensure that there is adequate drainage around turbine bases.

5.2.4 *Turbine bases and the water table – leaching*

Another consequence of submersion is that the foundation pad is subjected to hydrostatic pressure. Even though care is taken to ensure that the concrete is dense, homogeneous and free of cracks so that it has low permeability, water can seep through it under pressure. This is dangerous because concrete contains calcium hydroxide which can be leached out in seepage water, reducing the strength of the concrete, especially if the water contains carbon dioxide. Acid waters with a pH of less than 6.5 are known slowly to degrade concrete while humic acids (the main acids in peat) cause much more rapid degradation.[1]

[1] Cement & Concrete Association of New Zealand – www.cca.org.nz

5.3 *Turbine towers and blades – bird strikes*

There is considerable concern within the ornithological world about the possible impacts of wind turbines on bird populations. The uplands, being relatively free from regular human disturbance, tend to form the main refuges for a number of rarer bird species, especially raptors. A number of species protected under the EU Birds Directive and the EU Habitats & Species Directive are characteristic of the kind of blanket mire landscape found in the Slieve Aughty Mountains, including hen harrier, merlin, peregrine falcon and golden plover.

The level of concern has stimulated the Irish government to undertake a research programme into the impacts of wind farms on hen harriers in Ireland (Parliamentary Answer: Mr Cullen 2003). The new research will focus only on the hen harrier; questions about (for example) merlin, peregrine falcon or grouse will remain unanswered. The RSPB in its latest advice about wind farms and birds (RSPB 2004) states that the RSPB will object to wind farm proposals where:

- there is an inadequate assessment of the impacts on birds or their habitats;
- the assessment reveals potentially serious problems for birds or their habitats that cannot be controlled or avoided;
- there is insufficient information about the risks to birds and their habitats to conclude that there will not be a problem.

The most recent evidence about wind farms and bird collisions (Langston 2004) highlights the fact that high bird mortalities due to collisions have been recorded in particular for weather conditions involving poor visibility or that create flying conditions where manoeuvrability is difficult. The summit of Cashlaundrumlahan can be expected to have cloud cover fairly frequently, while strong westerly winds from the Atlantic must also be common. Both conditions render the summit area of the wind farm more hazardous than a similar wind farm at lower altitude. The report highlights in particular the danger to large, long-lived rare bird species with low reproductive rates, where a small increase in mortality can have a disproportionate impact on the population. Such concerns would thus apply equally to hen harrier, peregrine falcon and to merlin and would suggest that for such a large wind-farm development it would be important to determine usage of the area by such species.

Appendix 1

СЪД НА ЕВРОПЕЙСКИЯ СЪЮЗ
TRIBUNAL DE JUSTICIA DE LA UNIÓN EUROPEA
SOUDNÍ DVŮR EVROPSKÉ UNIE
DEN EUROPÆISKE UNIONS DOMSTOL
GERICHTSHOF DER EUROPÄISCHEN UNION
EUROOPA LIIDU KOHUS
ΔΙΚΑΣΤΗΡΙΟ ΤΗΣ ΕΥΡΩΠΑΪΚΗΣ ΕΝΩΣΗΣ
COURT OF JUSTICE OF THE EUROPEAN UNION
COUR DE JUSTICE DE L'UNION EUROPÉENNE
CÚIRT BHREITHIÚNAIS AN AONTAIS EORPAIGH
SUD EUROPSKE UNIJE
CORTE DI GIUSTIZIA DELL'UNIONE EUROPEA
CVRIA
LUXEMBOURG
EIROPAS SAVIENĪBAS TIESA
EUROPOS SĄJUNGOS TEISINGUMO TEISMAS
AZ EURÓPAI UNIÓ BÍRÓSÁGA
IL-QORTI TAL-ĠUSTIZZJA TAL-UNJONI EWROPEA
HOF VAN JUSTITIE VAN DE EUROPESE UNIE
TRYBUNAŁ SPRAWIEDLIWOŚCI UNII EUROPEJSKIEJ
TRIBUNAL DE JUSTIÇA DA UNIÃO EUROPEIA
CURTEA DE JUSTIȚIE A UNIUNII EUROPENE
SÚDNY DVOR EURÓPSKEJ ÚNIE
SODIŠČE EVROPSKE UNIJE
EUROOPAN UNIONIN TUOMIOISTUIN
EUROPEISKA UNIONENS DOMSTOL

JUDGMENT OF THE COURT (Grand Chamber)

12 November 2019 *

(Failure of a Member State to fulfil obligations — Judgment of the Court establishing a failure to fulfil obligations — Non-compliance — Directive 85/337/EEC — Consent for, and construction of, a wind farm — Project likely to have significant effects on the environment — Absence of a prior environmental impact assessment — Obligation to regularise — Article 260(2) TFEU — Application for an order to pay a penalty payment and a lump sum)

In Case C-261/18,

ACTION under Article 260(2) TFEU for failure to fulfil obligations, brought on 13 April 2018,

European Commission, represented by M. Noll-Ehlers and J. Tomkin, acting as Agents,

applicant,

v

Ireland, represented by M. Browne, G. Hodge and A. Joyce, acting as Agents, and by J. Connolly and G. Simons, Senior Counsel, and G. Gilmore, Barrister-at-Law,

defendant,

THE COURT (Grand Chamber),

composed of K. Lenaerts, President, R. Silva de Lapuerta, Vice-President, J.-C. Bonichot (Rapporteur), A. Arabadjiev, A. Prechal, M. Safjan and S. Rodin, Presidents of Chambers, L. Bay Larsen, T. von Danwitz, C. Toader, F. Biltgen, K. Jürimäe and C. Lycourgos, Judges,

* Language of the case: English.

Advocate General: G. Pitruzzella,

Registrar: R. Şereş, administrator,

having regard to the written procedure and further to the hearing on 1 April 2019,

after hearing the Opinion of the Advocate General at the sitting on 13 June 2019,

gives the following

Judgment

1 By its application, the European Commission claims that the Court should:

- declare that, by failing to take the necessary measures to comply with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380) as regards the second indent of point 1 of the operative part thereto, Ireland has failed to fulfil its obligations under Article 260 TFEU;
- order Ireland to pay the Commission a lump sum of EUR 1 343.20 multiplied by the number of days between the delivery of the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380) and, either the date of compliance by Ireland with that judgment, or the date of the judgment delivered in the present case if that date is sooner than the date of compliance with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), with a minimum lump sum of EUR 1 685 000;
- order Ireland to pay the Commission a penalty payment of EUR 12 264 per day from the date of the judgment delivered in the present case to the date of compliance by Ireland with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380); and
- order Ireland to pay the costs.

Legal context

Directive 85/337/EEC before amendment by Directive 97/11

2 Article 2(1),(2) and (3), first subparagraph, of Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment (OJ 1985 L 175, p. 40) provided:

'1. Member States shall adopt all measures necessary to ensure that, before consent is given, projects likely to have significant effects on the environment by virtue inter alia, of their nature, size or location are made subject to an assessment with regard to their effects.

These projects are defined in Article 4.

2. The environmental impact assessment may be integrated into the existing procedures for consent to projects in the Member States, or, failing this, into other procedures or into procedures to be established to comply with the aims of this Directive.

3. Member States may, in exceptional cases, exempt a specific project in whole or in part from the provisions laid down in this Directive.'

3 Article 3 of that directive provided:

'The environmental impact assessment will identify, describe and assess in an appropriate manner, in the light of each individual case and in accordance with the Articles 4 to 11, the direct and indirect effects of a project on the following factors:

– human beings, fauna and flora,

– soil, water, air, climate and the landscape,

– the inter-action between the factors mentioned in the first and second indents,

– material assets and the cultural heritage.'

4 Article 4 of that directive was worded as follows:

'1. Subject to Article 2(3), projects of the classes listed in Annex I shall be made subject to an assessment in accordance with Articles 5 to 10.

2. Projects of the classes listed in Annex II shall be made subject to an assessment, in accordance with Articles 5 to 10, where Member States consider that their characteristics so require.

To this end Member States may inter alia specify certain types of projects as being subject to an assessment or may establish the criteria and/or thresholds necessary to determine which of the projects of the classes listed in Annex II are to be subject to an assessment in accordance with Articles 5 to 10.'

5 Article 5 of Directive 85/337 provided:

'1. In the case of projects which, pursuant to Article 4, must be subjected to an environmental impact assessment in accordance with Articles 5 to 10, Member States shall adopt the necessary measures to ensure that the developer supplies in an appropriate form the information specified in Annex III inasmuch as:

(a) the Member States consider that the information is relevant to a given stage of the consent procedure and to the specific characteristics of a particular

project or type of project and of the environmental features likely to be affected;

(b) the Member States consider that a developer may reasonably be required to compile this information having regard inter alia to current knowledge and methods of assessment.

2. The information to be provided by the developer in accordance with paragraph 1 shall include at least:

– a description of the project comprising information on the site, design and size of the project,

– a description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects,

– the data required to identify and assess the main effects which the project is likely to have on the environment,

– a non-technical summary of the information mentioned in indents 1 to 3.

3. Where they consider it necessary, Member States shall ensure that any authorities with relevant information in their possession make this information available to the developer.'

6 Article 6 of Directive 85/337 was worded as follows:

'1. Member States shall take the measures necessary to ensure that the authorities likely to be concerned by the project by reason of their specific environmental responsibilities are given an opportunity to express their opinion on the request for development consent. Member States shall designate the authorities to be consulted for this purpose in general terms or in each case when the request for consent is made. The information gathered pursuant to Article 5 shall be forwarded to these authorities. Detailed arrangements for consultation shall be laid down by the Member States.

2. Member States shall ensure that:

– any request for development consent and any information gathered pursuant to Article 5 are made available to the public,

– the public concerned is given the opportunity to express an opinion before the project is initiated.

…'

7 Article 7 of that directive provided:

'Where a Member State is aware that a project is likely to have significant effects on the environment in another Member State or where a Member State likely to be significantly affected so requests, the Member State in whose territory the project is intended to be carried out shall forward the information gathered pursuant to Article 5 to the other Member State at the same time as it makes it available to its own nationals. Such information shall serve as a basis for any consultations necessary in the framework of the bilateral relations between two Member States on a reciprocal and equivalent basis.'

8 Under Article 8 of Directive 85/337:

'Information gathered pursuant to Articles 5, 6 and 7 must be taken into consideration in the development consent procedure.'

9 Article 9 of that directive was worded as follows:

'When a decision has been taken, the competent authority or authorities shall inform the public concerned of:

- the content of the decision and any conditions attached thereto,
- the reasons and considerations on which the decision is based where the Member States' legislation so provides.

The detailed arrangements for such information shall be determined by the Member States.

If another Member State has been informed pursuant to Article 7, it will also be informed of the decision in question.'

10 Article 10 of Directive 85/337 provided:

'The provisions of this Directive shall not affect the obligation on the competent authorities to respect the limitations imposed by national regulations and administrative provisions and accepted legal practices with regard to industrial and commercial secrecy and the safeguarding of the public interest.

Where Article 7 applies, the transmission of information to another Member State and the reception of information by another Member State shall be subject to the limitations in force in the Member State in which the project is proposed.'

11 Annex II to Directive 85/337 listed the projects subject to Article 4(2) of that directive, namely those for which an environmental impact assessment was necessary only where the Member States considered that their characteristics so required. The projects referred to in point 2(a) of that annex were accordingly for the extraction of peat, and in point 2(c) of that annex, for the extraction of minerals other than metalliferous and energy-producing minerals, such as marble, sand, gravel, shale, salt, phosphates and potash.

Directive 85/337 following amendment by Directive 97/11

12 Article 2(1),(2) and (3), first subparagraph, of Directive 85/337/EEC, as amended by Council Directive 97/11/EC of 3 March 1997 (OJ 1997 L 73, p. 5) provides:

'1. Member States shall adopt all measures necessary to ensure that, before consent is given, projects likely to have significant effects on the environment by virtue, inter alia, of their nature, size or location are made subject to a requirement for development consent and an assessment with regard to their effects. These projects are defined in Article 4.

2. The environmental impact assessment may be integrated into the existing procedures for consent to projects in the Member States, or, failing this, into other procedures or into procedures to be established to comply with the aims of this Directive.

...

3. Without prejudice to Article 7, Member States may, in exceptional cases, exempt a specific project in whole or in part from the provisions laid down in this Directive.'

13 Article 3 of that directive provides:

'The environmental impact assessment shall identify, describe and assess in an appropriate manner, in the light of each individual case and in accordance with Articles 4 to 11, the direct and indirect effects of a project on the following factors:

- human beings, fauna and flora;
- soil, water, air, climate and the landscape;
- material assets and the cultural heritage;
- the interaction between the factors mentioned in the first, second and third indents.'

14 Article 4 of that directive provides:

'1. Subject to Article 2(3), projects listed in Annex I shall be made subject to an assessment in accordance with Articles 5 to 10.

2. Subject to Article 2(3), for projects listed in Annex II, the Member States shall determine through:

(a) a case-by-case examination,

or

Directive 85/337 following amendment by Directive 97/11

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'1. Subject to Article 2(3), projects listed in Annex I shall be made subject to an assessment in accordance with Articles 5 to 10.

2. Subject to Article 2(3), for projects listed in Annex II, the Member States shall determine through:

(a) a case-by-case examination,

or

(b) thresholds or criteria set by the Member State,

whether the project shall be made subject to an assessment in accordance with Articles 5 to 10.

Member States may decide to apply both procedures referred to in (a) and (b).

3. When a case-by-case examination is carried out or thresholds or criteria are set for the purpose of paragraph 2, the relevant selection criteria set out in Annex III shall be taken into account.

4. Member States shall ensure that the determination made by the competent authorities under paragraph 2 is made available to the public.'

15 Point 3(i) of Annex II to that directive refers to installations for the harnessing of wind power for energy production (wind farms).

16 Pursuant to point 13 of Annex II, any change or extension of projects listed in Annex I or Annex II, already authorised, executed or in the process of being executed, which may have significant adverse effects on the environment, must be regarded as a project falling within the scope of Article 4(2) of Directive 85/337.

17 Annex III to Directive 85/337, relating to the selection criteria referred to in Article 4(3) of that directive, states that the characteristics of projects must be considered in relation, inter alia, to pollution and nuisances, and to the risk of accidents having regard in particular to technologies used. That annex also states that the environmental sensitivity of geographical areas likely to be affected by projects must be considered having regard, inter alia, to the absorption capacity of the natural environment, paying particular attention to certain areas, including mountain and forest areas.

The judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380)

18 In its judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), the Court held that, by failing to adopt all measures necessary to ensure that:

– projects which are within the scope of Directive 85/337, either before or after amendment by Council Directive 97/11 ('Directive 85/337') are, before they are executed in whole or in part, first, considered with regard to the need for an environmental impact assessment and, secondly, where those projects are likely to have significant effects on the environment by virtue of their nature, size or location, that they are made subject to an assessment with regard to their effects in accordance with Articles 5 to 10 of Directive 85/337, and

- the development consents given for, and the execution of, wind farm developments and associated works at Derrybrien, County Galway (Ireland), were preceded by an assessment with regard to their environmental effects, in accordance with Articles 5 to 10 of that directive,

Ireland failed to fulfil its obligations under Articles 2, 4 and 5 to 10 of Directive 85/337.

19 As regards the second complaint relating to the absence of an assessment of the effects of the wind farm and the associated works at Derrybrien ('the wind farm'), the Court concluded that there was a failure to fulfil obligations on the grounds set out in paragraphs 94 to 111 of the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380).

20 In particular, as regards the first two phases of construction of the wind farm project, the Court stated, in paragraph 98 of that judgment, that Ireland was bound to subject the projects relating to that construction to an impact assessment if they were likely to have significant effects on the environment, by virtue, inter alia, of their nature, size or location.

21 In that regard, the Court held, in paragraph 103 of that judgment, that the location and size of the projects of peat and mineral extraction and road construction, and the proximity of the site to a river, constituted specific characteristics which demonstrated that those projects, which were inseparable from the installation of 46 wind turbines, were likely to have significant effects on the environment and, accordingly, had to be subject to an assessment of their effects on the environment.

22 In addition, as regards the application for consent relating to the third phase of construction of the wind farm and for alteration of the first two phases of construction originally authorised, the Court found, in paragraph 110 of that judgment, that since the installation of 25 new turbines, the construction of new service roadways and the change in the type of wind turbines initially authorised — which was intended to increase the production of electricity — were projects which were likely to have significant effects on the environment, they should, before being authorised, have therefore been subject to a requirement for development consent and to an assessment of their effects on the environment, in conformity with the conditions laid down in Articles 5 to 10 of Directive 85/337.

Pre-litigation procedure and proceedings before the Court

23 Following the delivery of the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), the Commission, by letter dated 15 July 2008, requested Ireland to provide it, within 2 months of the date of that judgment, with information on the measures taken in order to comply with the terms of that judgment. By letter dated 3 September 2008, Ireland confirmed in particular that it fully accepted the judgment and that an updated environmental impact

— the development consents given for, and the execution of, wind farm developments and associated works at Derrybrien, County Galway (Ireland), were preceded by an assessment with regard to their environmental effects, in accordance with Articles 5 to 10 of that directive,

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assessment, in compliance with Directive 85/337, was anticipated before the end of 2008.

24 By letters of 10 March and 17 April 2009, and further to a meeting with the Commission, Ireland informed the latter that it was drafting a bill in order to introduce a regularisation procedure which, in exceptional cases, would allow for consents granted in breach of Directive 85/337 to be regularised through the grant of 'substitute consent' and that, in accordance with that procedure, the wind farm operator would apply for such consent.

25 On 26 June 2009, the Commission sent a letter of formal notice to that Member State, in which it stated, first, that it had received only a preliminary outline of the legislation to be enacted by Ireland in order to ensure compliance with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), and, secondly, that it was still awaiting information on the envisaged assessment of the wind farm's effects on the environment. On 9 September 2009, Ireland replied to that letter of formal notice, confirming, first, that the legislative change introducing the substitute consent procedure would shortly be enacted and that the wind farm operator had agreed in principle to apply for substitute consent.

26 On 22 March 2010, the Commission sent a further letter of formal notice to Ireland requesting it to submit observations to the Commission within 2 months of receipt of that letter. Ireland replied by letters dated 18 May 2010, 22 July 2010 and 13 September 2010. In the letter of 13 September 2010, the Irish authorities informed the Commission of the enactment in July 2010 of the Planning and Development (Amendment) Act 2010 ('the PDAA'). Part XA of the PDAA, in particular Sections 177B and 177C thereto, provides for a regularisation procedure for consents granted in breach of the obligation to conduct an environmental impact assessment.

27 Following further contacts between the Irish authorities and the Commission and the notification by Ireland of additional legislative measures adopted between 2010 and 2012, the Commission, by letter of 19 September 2012, requested Ireland to inform it in particular whether the developer of the wind farm would be subject to that regularisation procedure.

28 By letter dated 13 October 2012, Ireland stated that the wind farm operator, wholly owned by a semi-public sector company, was refusing to apply the regularisation procedure provided for in Part XA of the PDAA and that neither national nor EU law made provision for its application to be imposed. In particular, EU law, it was claimed, did not require the consents granted for the construction of the wind farm, which had become final, to be called into question and the principles of legal certainty and of the non-retroactive effect of laws, as well as the case-law of the Court on the procedural autonomy of the Member States, precluded the withdrawal of those consents.

29 By letter of 16 December 2013, the Irish authorities reported to the Commission that the wind farm operator had indicated its willingness to undertake an unofficial, that is non-statutory, environmental impact assessment in respect of that wind farm which would nevertheless conform to the requirements of Directive 85/337.

30 In the course of 2014, Ireland provided the Commission with a concept document which set out a road map for the non-statutory environmental impact assessment of the wind farm. Ireland also agreed, at a meeting with the Commission held on 13 May 2014, to send it the draft memorandum of understanding which would be concluded between the wind farm operator and the Irish Minister for Environment providing for an agreement on the carrying out of a non-statutory environmental review. Such a draft was provided to the Commission on 11 March 2015, with the Irish authorities communicating a further version of that draft on 7 March 2016.

31 The Commission stated on several occasions that those documents did not enable Ireland to fulfil its obligations. Following a meeting held on 29 November 2016, the Commission's services informed the Irish authorities by email on 15 December 2016 that the final text of the signed memorandum of understanding should reach the Commission by the end of 2016, failing which the Commission would refer the matter back to the Court in early 2017.

32 On 22 December 2016, Ireland sent the Commission a new version of the concept document and a scoping document dated 2 December 2015. In the covering letter, the Irish authorities stated that the two documents were due to be signed at the end of January 2017.

33 Following further exchanges with the Irish authorities, the Commission informed Ireland, by letter of 26 January 2018, that, notwithstanding the signature of the concept document, it considered that the failure to fulfil the obligation of complying fully with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380) persisted. Nine years after that judgment was delivered, no substantive progress had been made as regards the environmental impact assessment of the wind farm.

34 By letter of 1 February 2018, Ireland acknowledged that discussions on resolution of the case had already been ongoing for a number of years. In that letter, Ireland nonetheless maintained that it had awaited, before taking the measures necessary to comply, the Commission's observations on the documents that Ireland had sent it by letter of 22 December 2016.

35 Since it considered that the second indent of point 1 of the operative part of the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380) had still not been complied with, the Commission brought the present action.

36 Following the closure of the written part of the procedure in the present case, the Commission informed the Court, by letter lodged at the Registry on 1 April 2019, of a letter from the Irish authorities which it had received on 29 March 2019 ('the

letter of 29 March 2019') from which it is apparent that the wind farm operator had agreed that it would cooperate in a substitute consent procedure, to be initiated under the PDAA, 'as soon as possible, so as to ensure [that an *ex post* environmental impact assessment] is carried out.' On 1 April 2019, the Irish authorities also sent that letter to the Court Registry.

The failure to fulfil obligations

Arguments of the parties

37 The Commission notes that, in its judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), the Court held, in particular, that Ireland had failed to fulfil its obligations under Directive 85/337 in that it had failed to take all measures necessary to ensure that the development consents given for, and the execution of, the wind farm developments and associated works were preceded by an environmental impact assessment. According to the Commission, Ireland does not deny that it is under an obligation to take positive steps to address that failure.

38 The Commission submits that it was not for the Court to determine, in that judgment, the specific measures enabling the failure to fulfil obligations declared to be remedied. It is apparent, on the other hand, from the case-law of the Court (judgments of 7 January 2004, *Wells*, C-201/02, EU:C:2004:12, paragraphs 64 and 65, and of 28 February 2012, *Inter-Environnement Wallonie and Terre wallonne*, C-41/11, EU:C:2012:103, paragraphs 42, 43 and 46) that Ireland is required to eliminate the unlawful consequences of the failure to carry out an environmental impact assessment of the wind farm and to take all measures necessary to remedy that failure. In any event, mere preparatory steps, such as those taken in the present case, are insufficient.

39 In support of its arguments, the Commission also relies on the judgments of 26 July 2017, *Comune di Corridonia and Others* (C-196/16 and C-197/16, EU:C:2017:589, paragraph 35) and of 28 February 2018, *Comune di Castelbellino* (C-117/17, EU:C:2018:129, paragraph 30), which confirm that the competent national authorities are under an obligation to take all measures necessary, within the sphere of their competence, to remedy the failure to carry out an environmental impact assessment, for example by revoking or suspending consent already granted, in order to carry out such an assessment. EU law does not preclude regularisation through the conducting of an environmental impact assessment, subject to certain conditions.

40 During the pre-litigation procedure, Ireland made two different proposals, referred to in paragraphs 24 and 29 above, in order to remedy the failure to assess the wind farm's impact without, however, giving concrete effect to them.

41 First, Ireland referred to the possibility of carrying out a non-statutory assessment. However, no specific measure to implement it has been adopted.

42 Secondly, the Commission submits that Ireland amended its legislation in order to establish a procedure that would allow for the regularisation of consents granted in breach of the obligation to conduct an environmental impact assessment under EU law. However, Ireland now maintains that that procedure, provided for in Part XA of the PDAA, could be applied only prospectively and that, notwithstanding the fact that the wind farm operator is a wholly owned subsidiary of a semi-public sector company, it cannot be required to apply it.

43 The Commission submits, however, that Ireland is required to revoke or suspend the consents at issue and carry out an ex post remedial assessment, even if those measures affect the wind farm operator's vested rights. The possibility for a Member State to rely, in that regard, on the principle of procedural autonomy is, in accordance with the judgment of 17 November 2016, *Stadt Wiener Neustadt* (C-348/15, EU:C:2016:882, paragraph 40), limited by the principles of effectiveness and equivalence.

44 In addition, it is apparent from the judgment of 14 June 2007, *Medipac-Kazantzidis* (C-6/05, EU:C:2007:337, paragraph 43) that the wind farm operator is subject to the obligations arising from EU directives since it is a wholly owned subsidiary of an entity controlled by the public authorities.

45 Moreover, the Commission submits that the delay in complying with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), cannot be justified. In accordance with the case-law of the Court (judgment of 9 December 2008, *Commission* v *France*, C-121/07, EU:C:2008:695, paragraph 21), although Article 260 TFEU does not specify the period within which a judgment must be complied with, the process of compliance must be initiated at once and completed as soon as possible. In the present case, neither the complexity of the issues arising nor the alleged breakdown of communications between Ireland and the Commission at the end of 2016 can justify that Member State's failure to take action over a prolonged period. The Commission further notes that it had stated that December 2016 was the final deadline for complying with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380).

46 In its reply, the Commission submits that Ireland has still not carried out, by way of regularisation, an environmental impact assessment of the wind farm. Consequently, Ireland has not taken the minimum steps required to comply with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380).

47 Ireland contends that the Commission's action should be dismissed.

48 It contends that it is apparent from the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380) and the pleadings in the case giving rise to that judgment, that the two indents of point 1 of the operative part in that judgment related in fact to one and the same failure to fulfil obligations, namely the failure to transpose in full Directive 85/337. Consequently, apart from

transposing that directive, the adoption of specific measures as regards the wind farm was not necessary.

49 In addition, in its application, the Commission failed to identify the specific measures which it considers Ireland as being required to take in order to comply with the second indent of point 1 of the operative part of that judgment.

50 Furthermore, that same judgment did not set aside or invalidate the development consents granted between 1998 and 2003 for the wind farm's construction. Infringement proceedings pursuant to Article 226 EC (now Article 258 TFEU) cannot have any effect on the vested rights of third parties, in particular when those third parties are not heard in those proceedings.

51 As regards the procedures enabling a national administrative decision to be annulled, they fall within the procedural autonomy of the Member States. The judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380, paragraph 59), confirms that an obligation to remedy a failure to carry out an environmental impact assessment is limited by the procedural framework applicable within each Member State. In Ireland, a development consent may only be set aside by the High Court, on a direct application to that end.

52 In that regard, it is apparent from the judgment of 17 November 2016, *Stadt Wiener Neustadt* (C-348/15, EU:C:2016:882), that, subject to compliance with certain conditions, Member States may establish time limits governing proceedings brought against decisions adopted in the field of town planning. Under Irish procedural law in force prior to the enactment of the PDAA, any challenge seeking to set aside a planning permission was subject to a two-month time limit. The PDAA itself set an eight-week time limit. Consequently, the consents granted for the wind farm's construction have become final.

53 Ireland contends that, accordingly, the situation of the present case may be distinguished from those of the cases giving rise to the judgments of 26 July 2017, *Comune di Corridonia and Others* (C-196/16 and C-197/16, EU:C:2017:589) and of 28 February 2018, *Comune di Castelbellino* (C-117/17, EU:C:2018:129) referred to by the Commission. It is apparent from the summary of the facts in those judgments that the development consents at issue were in fact annulled by a national court. It was in the course of the proceedings subsequent to those annulments, seeking the grant of fresh development consents for the projects concerned, that questions relating to the obligation to carry out an environmental impact assessment were raised.

54 The present case may also be distinguished from that which gave rise to the judgment of 7 January 2004, *Wells* (C-201/02, EU:C:2004:12), delivered in preliminary ruling proceedings in a dispute concerning a national permission which had been challenged within the time limits. The Court states in that judgment that it is for the national court to determine whether it is possible under domestic law for a consent already granted to be revoked or suspended. In

addition, in the judgment of 12 February 2008, *Kempter* (C-2/06, EU:C:2008:78), the Court confirmed that, where an administrative decision has become final, EU law does not require that a national authority be placed under an obligation, in principle, to reopen that decision.

55 Furthermore, where planning consents may no longer be subject to judicial review proceedings, the principles of the protection of legitimate expectations and of legal certainty and the property rights of the holders of planning permissions must be respected.

56 In the present case, the withdrawal of the consents granted, which have become final, would be contrary to the principle of legal certainty. Ireland is not, therefore, required to annul or withdraw them. A fortiori, nor is it required to carry out, *ex post facto*, an environmental impact assessment on the basis of the relevant provisions of the PDAA.

57 In the alternative, Ireland contends that it has now complied with the obligations stemming from the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), in that it has taken steps to arrange for a non-statutory assessment to be carried out at Derrybrien. The history of the engagement between Ireland and the Commission, as detailed in the application, demonstrates that the Irish Government has acted in good faith in that regard.

58 In support of that argument, Ireland contends, in particular, that the Irish Government drew up a concept paper in agreement with the wind farm's developer. That document provides that the developer will have to prepare an environmental report, in accordance with the scoping document, which will have to include possible mitigation measures. That document also provides that the report will be subject to a form of public consultation process.

59 The initiation of such a process constitutes sufficient compliance with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), since, contrary to the full transposition of Directive 85/337, which fell entirely under the control of the Irish authorities, the implementation of the assessment of the effects of a project on the environment in fact requires the participation of third parties.

60 In the further alternative, Ireland contends that it will have complied with its obligations at the latest as of the date of any hearing before the Court in the present case.

61 In addition, the duration of the procedure necessary to implement the environmental impact assessment of the wind farm is linked to the lack of reaction from the Commission following the submission, on 22 December 2016, of a new version of the concept document intended to prepare for the environmental impact assessment of the wind farm to be carried out. The Irish authorities awaited the formal approval of that document. In any event, a Member State cannot be penalised for taking the time necessary to discern the appropriate measures, for

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the purposes of complying with a judgment of the Court, or for failing to identify them.

62 At the hearing, Ireland confirmed that it no longer envisaged carrying out a non-statutory environmental impact assessment in relation to the wind farm. As is apparent from the letter of 29 March 2019, it now maintains that the wind farm operator has agreed that it will cooperate in order for a regularisation procedure under Part XA of the PDAA to be initiated. In the context of that procedure, an environmental impact assessment in accordance with Directive 85/337 will be carried out as soon as possible.

63 In answer to the questions put by the Court at the hearing, Ireland stated that the formal agreement of the wind farm's operator was still lacking. In addition, it is not decided whether the latter would itself apply for substitute consent pursuant to Section 177 C of the PDAA, or whether, pursuant to Section 177 B of the PDAA, the competent authorities would themselves commence the regularisation procedure of their own initiative.

Findings of the Court

Preliminary observations

64 In the context of the present action, brought on the basis of Article 260(2) TFEU, the Commission submits that Ireland has not complied with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), as regards the second complaint only, in the second indent of point 1 of the operative part of that judgment. The Court held, in that regard, that by failing to adopt all measures necessary to ensure that the development consents given for, and the execution of, the developments and associated works at the wind farm were preceded by an environmental impact assessment, in accordance with Articles 5 to 10 of Directive 85/337, Ireland failed to fulfil its obligations under Articles 2, 4 and 5 to 10 of that directive.

The admissibility of the action

65 In so far as Ireland contends, in essence, that the Commission has failed to define the subject matter of its action and to identify the measures that are necessary in order to comply with the second indent of point 1 of the operative part of the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), it must be found that it in fact contests the admissibility of the present action.

66 In that regard, the Commission submits, in its application, that, in order to comply with the second indent of point 1 of the operative part of the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), Ireland should eliminate the unlawful consequences of the breach of the obligation to carry out a prior environmental impact assessment of the wind farm and initiate, to that end, a procedure to regularise the project in question. That procedure should include an

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environmental impact assessment of that project in accordance with the requirements of Directive 85/337.

67 Consequently, Ireland is mistaken to complain that the Commission has failed to define the measures required to comply with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380) and, for that reason, to complain that the Commission has failed to specify sufficiently the subject matter of its action.

68 It must, therefore, be concluded that Ireland's contentions are not capable of affecting the admissibility of the present action.

The substance

69 Ireland contends that the present action is unfounded, arguing that, beyond the transposition of Directive 85/337, the adoption of specific measures as regards the wind farm is unnecessary and that, in particular, it is impossible, under its national law, to withdraw the consents granted to the wind farm's operator, which have become final.

70 The Commission submits, on the other hand, that Ireland is required, as recalled in paragraph 66 above, to eliminate the unlawful consequences of the failure to fulfil obligations established and, in the context of a regularisation procedure, to carry out an environmental impact assessment of the wind farm in accordance with the requirements of Directive 85/337.

71 In those circumstances, it is necessary to examine the obligations on a Member State when a project has been authorised in breach of the obligation to carry out a prior environmental impact assessment under Directive 85/337, in particular where the consent was not challenged within the period prescribed by national law and has, therefore, become final in the national legal order.

72 In that regard, it should be borne in mind that, under Article 2(1) of Directive 85/337, projects likely to have significant effects on the environment, as referred to in Article 4 of that directive, read in conjunction with Annexes I or II thereto, must be made subject to an assessment with regard to such effects before consent is given (judgment of 7 January 2004, *Wells*, C-201/02, EU:C:2004:12, paragraph 42).

73 The requirement to undertake such an assessment in advance is justified by the fact that it is necessary for the competent authority to take effects on the environment into account at the earliest possible stage in all the technical planning and decision-making processes, the objective being to prevent the creation of pollution or nuisances at source rather than subsequently trying to deal with their effects (judgments of 3 July 2008, *Commission* v *Ireland*, C-215/06, EU:C:2008:380, paragraph 58, and of 26 July 2017, *Comune di Corridonia and Others*, C-196/16 and C-197/16, EU:C:2017:589, paragraph 33).

74 However, Directive 85/337 does not contain provisions governing the consequences of a breach of that obligation to carry out a prior assessment (see, to that effect, judgment of 26 July 2017, *Comune di Corridonia and Others*, C-196/16 and C-197/16, EU:C:2017:589, paragraph 34).

75 Under the principle of sincere cooperation provided for in Article 4(3) TEU, Member States are nevertheless required to eliminate the unlawful consequences of that breach of EU law. That obligation applies to every organ of the Member State concerned and, in particular, to the national authorities which have the obligation to take all measures necessary, within the sphere of their competence, to remedy the failure to carry out an environmental impact assessment, for example by revoking or suspending consent already granted, in order to carry out such an assessment (see, to that effect, judgments of 7 January 2004, *Wells*, C-201/02, EU:C:2004:12, paragraph 64, and of 26 July 2017, *Comune di Corridonia and Others*, C-196/16 and C-197/16, EU:C:2017:589, paragraph 35).

76 As regards the possibility of regularising such an omission a posteriori, Directive 85/337 does not preclude national rules which, in certain cases, permit the regularisation of operations or measures which are unlawful in the light of EU law, provided that such a possibility does not offer the persons concerned the chance to circumvent the rules of EU law or to dispense with their application, and that it should remain the exception (judgment of 26 July 2017, *Comune di Corridonia and Others*, C-196/16 and C-197/16, EU:C:2017:589, paragraphs 37 and 38).

77 An assessment carried out in the context of such a regularisation procedure, after a plant has been constructed and has entered into operation cannot be confined to its future impact on the environment, but must also take into account its environmental impact from the time of its completion (see, to that effect, judgment of 26 July 2017, *Comune di Corridonia and Others*, C-196/16 and C-197/16, EU:C:2017:589, paragraph 41).

78 By contrast, Directive 85/337 precludes national legislation which allows the national authorities, where no exceptional circumstances are proved, to issue regularisation permission which has the same effects as those attached to a prior consent granted after an environmental impact assessment carried out in accordance with Article 2(1) and Article 4(1) and (2) of that directive (see, to that effect, judgments of 3 July 2008, *Commission* v *Ireland*, C-215/06, EU:C:2008:380, paragraph 61; of 17 November 2016, *Stadt Wiener Neustadt*, C-348/15, EU:C:2016:882, paragraph 37; and of 26 July 2017, *Comune di Corridonia and Others*, C-196/16 and C-197/16, EU:C:2017:589, paragraph 39).

79 Directive 85/337 also precludes a legislative measure, which would allow, without even requiring a later assessment and even where no exceptional circumstances are proved, a project which ought to have been subject to an environmental impact assessment, within the meaning of Article 2(1) of Directive 85/337, to be deemed to have been subject to such an assessment (see, to that effect, judgment of

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17 November 2016, *Stadt Wiener Neustadt*, C-348/15, EU:C:2016:882, paragraph 38).

80 Similarly, Directive 85/337 precludes projects in respect of which the consent can no longer be subject to challenge before the courts, because the time limit for bringing proceedings laid down in national legislation has expired, from being purely and simply deemed to be lawfully authorised as regards the obligation to assess their effects on the environment (judgment of 17 November 2016, *Stadt Wiener Neustadt*, C-348/15, EU:C:2016:882, paragraph 43).

81 In the present case, it is not in dispute that, during a legislative reform in July 2010, Ireland introduced into its legislation a procedure for regularising projects which had been authorised in breach of the obligation to carry out an environmental impact assessment. It is apparent from the file before the Court that the detailed rules for that procedure were laid down in Part XA of the PDAA, the provisions of which were enacted in order to comply with the requirements flowing from the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380).

82 First, according to Section 177 B(1) and (2)(b) of Part XA of the PDAA, where, in particular, by 'a final judgment of ... the Court of Justice of the European Union', it is held that a permission for a project for which an environmental impact assessment was required was unlawfully granted, the competent planning authority must give notice in writing directing the project manager to apply for substitute consent. Subsection (2)(c) of Section 177 B of Part XA of the PDAA states that the notice is to require the project manager to furnish a remedial environmental impact statement with the application.

83 Secondly, Section 177 C of Part XA of the PDAA enables, in those same circumstances, the manager of a project authorised in breach of the obligation to carry out a prior environmental impact assessment to apply itself for the regularisation procedure to be initiated. If its application is allowed, the manager must furnish, in accordance with Section 177 D(7)(b) of Part XA of the PDAA, a remedial environmental impact statement.

84 The fact remains that, as at the reference date for assessing whether there has been a failure to fulfil obligations under Article 260(2) TFEU, namely the expiry of the period prescribed in the letter of formal notice issued under that provision (see, to that effect, judgment of 11 December 2012, *Commission* v *Spain*, C-610/10, EU:C:2012:781, paragraph 67), that is to say, in accordance with the letter of formal notice of 22 March 2010 mentioned in paragraph 26 above, at the end of May 2010, Ireland had failed to carry out a new environmental impact assessment of the wind farm within the context of the regularisation of the consents at issue and thereby failed to have regard to the authority attaching to the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), as regards the second indent of point 1 of the operative part thereto.

85 Ireland nonetheless argued, at the hearing, that, as regards the consents granted for the construction of the wind farm, it is not ultimately in a position to apply the regularisation procedure of its own initiative. After commencing that procedure pursuant to Section 177 B of Part XA of the PDAA, the local authorities that were responsible in that regard put an end to that procedure. Although those authorities are an emanation of the State, they are independent and therefore fall outside the Irish Government's control.

86 Similarly, Ireland contends that it could not require the wind farm operator to apply for substitute consent pursuant to Section 177 C of Part XA of the PDAA. Admittedly, that operator is a wholly owned subsidiary of a semi-public sector entity that is 90% owned by Ireland. However, the operator is independent as regards the daily management of its affairs.

87 Ireland also contends that the principles of legal certainty and of the protection of legitimate expectations preclude the revocation of an administrative decision, such as the consents at issue in the present case, which because of the expiry of the period for bringing an action, can no longer be the subject of a direct application to a court and has, therefore, become final.

88 Ireland's arguments must, however, be rejected.

89 First of all, the Court points out that, according to settled case-law, a Member State cannot plead provisions, practices or situations prevailing in its domestic legal order to justify failure to observe obligations arising under EU law (judgments of 2 December 2014, *Commission* v *Greece*, C-378/13, EU:C:2014:2405, paragraph 29, and of 24 January 2018, *Commission* v *Italy*, C-433/15, EU:C:2018:31, paragraph 56 and the case-law cited). It follows that Ireland, for the purposes of justifying the failure to comply with the obligations stemming from the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), cannot rely on national provisions limiting the possibilities for commencing a regularisation procedure, such as Section 177 B and Section 177 C of Part XA of the PDAA, a procedure which it introduced into its national legislation specifically in order to ensure compliance with that judgment.

90 In any event, as regards the alleged impossibility for that Member State to require the competent local authorities to commence the regularisation procedure provided for by the Irish legislation, it must be borne in mind that, according to the case-law cited in paragraph 75 above, every organ of that Member State and, in particular, those local authorities are required to take all measures necessary, within the sphere of their competence, to remedy the failure to carry out an environmental impact assessment of the wind farm.

91 As regards, next, the wind farm operator's inaction, or even its refusal to initiate the regularisation procedure pursuant to Section 177 C of Part XA of the PDAA, it suffices to refer, *mutatis mutandis*, to the considerations set out in paragraph 89 above, since that operator is controlled by Ireland. Consequently, the operator

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must be considered an emanation of that Member State on which, as the Commission rightly argued, the obligations arising from EU directives are binding (judgment of 14 June 2007, *Medipac — Kazantzidis*, C-6/05, EU:C:2007:337, paragraph 43 and the case-law cited).

92 As regards Ireland's argument based on the contention that the principle of legal certainty and the principle of the protection of legitimate expectations preclude the consents unlawfully granted to the wind farm's operator from being withdrawn, it must be borne in mind, first, that the infringement procedure is based on the objective finding that a Member State has failed to fulfil its obligations under the Treaty or secondary legislation and, secondly, that while the withdrawal of an unlawful measure must occur within a reasonable time and regard must be had to how far the person concerned might have been led to rely on the lawfulness of the measure, the fact remains that such withdrawal is, in principle, permitted (judgment of 4 May 2006, *Commission* v *United Kingdom*, C-508/03, EU:C:2006:287, paragraphs 67 and 68).

93 Ireland cannot, therefore, rely on legal certainty and legitimate expectations derived by the operator concerned from acquired rights in order to contest the consequences flowing from the objective finding that Ireland has failed to fulfil its obligations under Directive 85/337 with regard to assessment of the effects of certain projects on the environment (see, to that effect, judgment of 4 May 2006, *Commission* v *United Kingdom*, C-508/03, EU:C:2006:287, paragraph 69).

94 In any event, Ireland simply states that, after the expiry of the period of 2 months, or 8 weeks set by the PDAA, respectively, the consents at issue could no longer be the subject of a direct application to a court and cannot be called in question by the national authorities.

95 By its argument, Ireland fails to have regard, however, to the case-law of the Court referred to in paragraph 80 above, according to which projects in respect of which the consent can no longer be subject to challenge before the courts, because the time limit for bringing proceedings laid down in national legislation has expired, cannot be purely and simply deemed to be lawfully authorised as regards the obligation to assess their effects on the environment.

96 It must further be noted that while it is not precluded that an assessment carried out after the plant concerned has been constructed and has entered into operation, in order to remedy the failure to carry out an environmental impact assessment of that plant before the consents were granted, may result in those consents being withdrawn or amended, this is without prejudice to any right of an economic operator, which has acted in accordance with a Member State's legislation that has proven contrary to EU law, to bring against that State, pursuant to national rules, a claim for compensation for the damage sustained as a result of the State's actions or omissions.

97 In the light of the foregoing, it must be held that, by failing to take all measures necessary to comply with the second indent of point 1 of the operative part of the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), Ireland has failed to fulfil its obligations under Article 260(1) TFEU.

The financial penalties

Arguments of the parties

98 Taking the view that Ireland has still not complied with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), the Commission claims that the Court should order Ireland to pay a lump sum of EUR 1 343.20 multiplied by the number of days between the delivery of that judgment and, either the date of compliance by Ireland with that judgment, or the date of the judgment delivered in the present case if that date is sooner than the date of compliance with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), with a minimum lump sum of EUR 1 685 000.

99 The Commission also claims that the Court should order Ireland to pay a penalty payment of EUR 12 264 per day from the date of the judgment delivered in the present case to the date of compliance by Ireland with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380).

100 Referring to its communication SEC(2005) 1658 of 12 December 2005, entitled 'Application of Article [260 TFEU]', as updated by its communication of 15 December 2017, entitled 'Updating of data used to calculate lump sum and penalty payments to be proposed by the Commission to the [Court] in infringement proceedings' (OJ 2017 C 431, p. 3), the Commission proposes that the daily penalty payment be determined by multiplying a standard flat-rate amount of EUR 700 by a coefficient for seriousness of 2 on a scale of 1 to 20 and also by a coefficient for duration of 3, that is the maximum coefficient. The result obtained would be multiplied by an 'n' factor, set at 2.92 for Ireland. As regards the calculation of the lump sum, the flat-rate amount would be set at EUR 230 per day and should by multiplied by a coefficient for seriousness of 2 and an 'n' factor set at 2.92. The total obtained would be multiplied by the number of days during which the failure to fulfil obligations persists.

101 As regards the seriousness of the failure to fulfil obligations, the Commission submits that account must be taken of the objectives of an environmental impact assessment, such as that provided for by Directive 85/337, of the facts established by the Court in paragraphs 102 and 104 of the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), and of the landslide, linked to the construction of the wind farm, which caused substantial environmental damage.

102 In addition, the Commission submits that cases brought before the Court show that Ireland has already infringed Directive 85/337 on several occasions. While Ireland has in the meantime proceeded to transpose that directive, the fact remains that, in the Commission's view, it has not made any progress such as to remedy the failure to fulfil obligations at issue, which has persisted over a particularly long period.

103 As regards the duration of the infringement, the Commission states that the adoption of regularisation measures is entirely Ireland's responsibility and does not depend on the Commission's opinion. Ireland ought to have adopted such measures as soon as possible.

104 Ireland contends that, in the present case, it has already complied with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), since it has taken the measures within its control in adopting a concept document providing for an environmental impact assessment of the wind farm by its operator.

105 The fact that a certain lapse of time was necessary in order to draw up that document does not constitute a failure to fulfil obligations, since consultation with the Commission was essential for the purposes of determining the content of that document.

106 In addition, the Commission's application fails to identify the measures whose adoption is required in order to comply with the second indent of point 1 of the operative part of the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380). The objective of setting a penalty payment is precisely to ensure compliance with that judgment.

107 In any event, the circumstances of the present case may be distinguished, on the ground referred to in paragraph 53 above, from those giving rise to the judgments of 26 July 2017, *Comune di Corridonia and Others* (C-196/16 and C-197/16, EU:C:2017:589) and of 28 February 2018, *Comune di Castelbellino* (C-117/17, EU:C:2018:129). If the Court held, however, that those judgments support the Commission's line of argument, they would mark a departure in the case-law in that area. Consequently, no penalty ought to accrue for any breach in the period before July 2017.

108 Ireland further observes that the Commission's communications are not binding upon the Court and that the Court is required to set an appropriate and proportionate penalty. The present case is unique and anomalous, which the Court must take into account when it determines the amount of the financial penalties.

109 As regards the seriousness of the infringement, Ireland contends that the minimum coefficient should apply, in particular in the light of the full transposition of Directive 85/337, the good faith shown by Ireland and the factual and legal difficulties of the present case. Account must also be taken of progress made by Ireland as regards compliance with its obligations and the fact that it is not proven

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that the landslide at Derrybrien was linked to the construction of the wind farm. In addition, Ireland has cooperated with the Commission constructively and has been committed to achieving a resolution for the problems at issue. The delay between December 2016 and October 2017 is attributable to a simple misunderstanding between Ireland and the Commission and is not indicative of a lack of cooperation.

110 Given the particular circumstances of the present case and the difficulties of establishing a regularisation mechanism consistent with the principles of legal certainty and of the protection of legitimate expectations, it is likewise not appropriate to apply a duration coefficient.

Findings of the Court

111 As a preliminary point, it should be borne in mind that, in each case, it is for the Court to determine, in the light of the circumstances of the case before it and according to the degree of persuasion and deterrence which appears to it to be required, the financial penalties appropriate, in particular, for preventing the recurrence of similar infringements of EU law (judgment of 14 November 2018, *Commission* v *Greece*, C-93/17, EU:C:2018:903, paragraph 107 and the case-law cited).

The lump sum payment

112 As a preliminary point it must be borne in mind that, in exercising the discretion conferred on it in such matters, the Court is empowered to impose a penalty payment and a lump sum payment cumulatively (judgment of 14 November 2018, *Commission* v *Greece*, C-93/17, EU:C:2018:903, paragraph 153).

113 The imposition of a lump sum payment and the fixing of that sum must depend in each individual case on all the relevant factors relating both to the characteristics of the failure to fulfil obligations established and to the conduct of the Member State involved in the procedure initiated under Article 260 TFEU. That provision confers a wide discretion on the Court in deciding whether to impose such a penalty and, if it decides to do so, in determining the amount (judgment of 14 November 2018, *Commission* v *Greece*, C-93/17, EU:C:2018:903, paragraph 154).

114 In addition, it is for the Court, in the exercise of its discretion, to fix the lump sum in an amount appropriate to the circumstances and proportionate to the infringement. Relevant considerations in this respect include factors such as the seriousness of the infringement and the length of time for which the infringement has persisted since the delivery of the judgment establishing it, and the relevant Member State's ability to pay (see, to that effect, judgments of 2 December 2014, *Commission* v *Italy*, C-196/13, EU:C:2014:2407, paragraphs 117 and 118, and of 14 November 2018, *Commission* v *Greece*, C-93/17, EU:C:2018:903, paragraphs 156, 157 and 158).

115 In the first place, as regards the seriousness of the infringement, it must be borne in mind that the objective of protecting the environment constitutes one of the essential objectives of the European Union and is both fundamental and inter-disciplinary in nature (see, to that effect, judgment of 28 February 2012, *Inter-Environnement Wallonie and Terre wallonne*, C-41/11, EU:C:2012:103, paragraph 57 and the case-law cited).

116 An environmental impact assessment, such as that provided for by Directive 85/337, is one of the fundamental environmental protection mechanisms in that it enables, as recalled in paragraph 73 above, the creation of pollution or nuisances to be prevented at source rather than subsequently trying to deal with their effects.

117 In accordance with the case-law recalled in paragraph 75 above, in the event of a breach of the obligation to assess the environmental impact, Member States are nevertheless required by EU law to eliminate at least the unlawful consequences of that breach (see, to that effect, judgment of 26 July 2017, *Comune di Corridonia and Others*, C-196/16 and C-197/16, EU:C:2017:589, paragraph 35).

118 As is apparent from paragraphs 23 to 36 above, from the time it was held in the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380) that there was a failure to fulfil obligations, consisting in the breach of the obligation to carry out an environmental impact assessment before consent for, and construction of, the wind farm, more than 11 years have elapsed without Ireland adopting the measures necessary in order to comply with the second indent of point 1 of the operative part of that judgment.

119 Admittedly, in July 2010 Ireland enacted the PDAA, Part XA of which provides for a procedure for regularising the projects authorised in breach of the obligation to carry out an environmental impact assessment. However, a little over 2 years later, Ireland informed the Commission that it was not going to apply the regularisation procedure, whereas, from April 2009 it had been stating the contrary. On the other hand, Ireland proposed to carry out an unofficial, non-statutory assessment. By letter of 29 March 2019, and thus 2 days before the hearing before the Court in the present case, Ireland changed its position again and now contends that the wind farm operator will request that the regularisation procedure provided for in Part XA of the PDAA be applied. At the hearing, Ireland was, however, unable to state whether that procedure would be commenced, on their own initiative, by the competent authorities, pursuant to Section 177 B of Part XA of the PDAA, or on the application of the operator, pursuant to Section 177 C of Part XA of the PDAA. Nor was it in a position to state the start date for the procedure. To date, the Court has received no other information in that regard.

120 It must be found that, in those circumstances, Ireland's conduct shows that it has not acted in accordance with its duty of sincere cooperation to put an end to the failure to fulfil obligations established in the second indent of point 1 of the

operative part of the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), which constitutes an aggravating circumstance.

121 Since that judgment has not yet been complied with, the Court cannot, therefore, but confirm the particularly lengthy character of an infringement which, in the light of the environmental protection aim pursued by Directive 85/337, is a matter of indisputable seriousness (see, by analogy, judgment of 22 February 2018, *Commission* v *Greece*, C-328/16, EU:C:2018:98, paragraph 94).

122 As regards, in the second place, the duration of the infringement, it should be borne in mind that that duration must be assessed by reference to the date on which the Court assesses the facts and not the date on which proceedings are brought before it by the Commission. In the present case, the duration of the infringement, of over 11 years from the date of delivery of the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), is considerable (see, by analogy, judgment of 22 February 2018, *Commission* v *Greece*, C-328/16, EU:C:2018:98, paragraph 99).

123 Although Article 260(1) TFEU does not specify the period within which a judgment must be complied with, it follows from settled case-law that the importance of immediate and uniform application of EU law means that the process of compliance must be initiated at once and completed as soon as possible (judgment of 22 February 2018, *Commission* v *Greece*, C-328/16, EU:C:2018:98, paragraph 100).

124 In the third place, as regards the ability to pay of the Member State concerned, it is apparent from the case-law of the Court that it is necessary to take account of recent trends in that Member State's gross domestic product (GDP) at the time of the Court's examination of the facts (judgment of 22 February 2018, *Commission* v *Greece*, C-328/16, EU:C:2018:98, paragraph 101).

125 Having regard to all the circumstances of the present case, it must be found that if the future repetition of similar infringements of EU law is to be effectively prevented, a lump sum payment of EUR 5 000 000 must be imposed.

126 Ireland must, therefore, be ordered to pay the Commission a lump sum of EUR 5 000 000.

The penalty payment

127 According to settled case-law, the imposition of a penalty payment is, in principle, justified only in so far as the failure to comply with an earlier judgment of the Court continues up to the time of the Court's examination of the facts (judgment of 14 November 2018, *Commission* v *Greece*, C-93/17, EU:C:2018:903, paragraph 108 and the case-law cited).

128 In the present case, it is not in dispute that, as noted, in particular in paragraphs 118 and 119 above, Ireland has still not carried out an environmental

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128 In the present case, it is not in dispute that, as noted, in particular in paragraphs 118 and 119 above, Ireland has still not carried out an environmental-

impact assessment of the wind farm in the context of a procedure for regularising the consents at issue, granted in breach of the obligation to carry out a prior environmental impact assessment laid down in Directive 85/337. As at the date on which the facts were examined by it, the Court does not have any information that would show that there has been any change to that situation.

129 In the light of the foregoing, it must be held that the failure to fulfil obligations of which Ireland stands criticised continued up until the Court's examination of the facts in the present case.

130 In those circumstances, the Court considers that an order imposing a penalty payment on Ireland is an appropriate financial means by which to induce it to take the measures necessary to bring to an end the failure to fulfil obligations established and to ensure full compliance with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380).

131 As regards the calculation of the amount of the penalty payment, according to settled case-law, the penalty payment must be decided upon according to the degree of persuasion needed in order for the Member State which has failed to comply with a judgment establishing a breach of obligations to alter its conduct and bring to an end the infringement established. In exercising its discretion in the matter, it is for the Court to set the penalty payment so that it is both appropriate to the circumstances and proportionate to the infringement established and the ability to pay of the Member State concerned (judgment of 14 November 2018, *Commission* v *Greece*, C-93/17, EU:C:2018:903, paragraphs 117 and 118).

132 The Commission's proposals regarding the amount of the penalty payment cannot bind the Court and are merely a useful point of reference. The Court must remain free to set the penalty payment to be imposed in an amount and in a form that it considers appropriate for the purposes of inducing the Member State concerned to bring to an end its failure to comply with its obligations arising under EU law (see, to that effect, judgment of 14 November 2018, *Commission* v *Greece*, C-93/17, EU:C:2018:903, paragraph 119).

133 For the purposes of determining the amount of a penalty payment, the basic criteria which must be taken into consideration in order to ensure that that payment has coercive effect and that EU law is applied uniformly and effectively are, in principle, the seriousness of the infringement, its duration and the ability to pay of the Member State in question. In applying those criteria, regard must be had, in particular, to the effects on public and private interests of the failure to comply and to how urgent it is for the Member State concerned to be induced to fulfil its obligations (judgment of 14 November 2018, *Commission* v *Greece*, C-93/17, EU:C:2018:903, paragraph 120).

134 In the present case, having regard to all the legal and factual circumstances culminating in the breach of obligations established and the considerations set out

impact assessment of the wind farm in the context of a procedure for regularising the consents at issue, granted in breach of the obligation to carry out a prior environmental impact assessment laid down in Directive 85/337. As at the date on which the facts were examined by it, the Court does not have any information that would show that there has been any change to that situation.

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134 In the present case, having regard to all the legal and factual circumstances culminating in the breach of obligations established and the considerations set out

in paragraphs 115 to 124 above, the Court considers it appropriate to impose a penalty payment of EUR 15 000 per day.

135 Ireland must, therefore be ordered to pay the Commission a periodic penalty payment of EUR 15 000 per day of delay of implementing the measures necessary in order to comply with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380) from the date of delivery of the present judgment until the date of compliance with that judgment of 3 July 2008.

Costs

136 Under Article 138(1) of the Rules of Procedure of the Court, the unsuccessful party is to be ordered to pay the costs if they have been applied for in the successful party's pleadings. Since the Commission has applied for costs and Ireland has been unsuccessful, the latter must be ordered to pay the costs.

On those grounds, the Court (Grand Chamber) hereby:

1. **Declares that, by failing to take all measures necessary to comply with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380), Ireland has failed to fulfil its obligations under Article 260(1) TFEU;**

2. **Orders Ireland to pay the European Commission a lump sum in the amount of EUR 5 000 000;**

3. **Orders Ireland to pay the Commission a periodic penalty payment of EUR 15 000 per day from the date of delivery of the present judgment until the date of compliance with the judgment of 3 July 2008, *Commission* v *Ireland* (C-215/06, EU:C:2008:380);**

4. Orders Ireland to pay the costs.

Lenaerts	Silva de Lapuerta	Bonichot
Arabadjiev	Prechal	Safjan
Rodin	Bay Larsen	von Danwitz
Toader	Biltgen	Jürimäe
	Lycourgos	

Delivered in open court in Luxembourg on 12 November 2019.

A. Calot Escobar	K. Lenaerts
Registrar	President

4. **Orders Ireland to pay the costs.**

Lenaerts	Silva de Lapuerta	Bonichot
Arabadjiev	Prechal	Safjan
Rodin	Bay Larsen	von Danwitz
Toader	Biltgen	Jürimäe
	Lycourgos	

Delivered in open court in Luxembourg on 12 November 2019.

A. Calot Escobar	K. Lenaerts
Registrar	President

Appendix 2

Our ref: Plan98
Dúchas The Heritage Service

Páirceanna Náisiúnta & An Fiadhúlra
51 Faiche Stiabhna
Baile Átha Cliath 2
Éire

National Parks & Wildlife
51 St. Stephen's Green
Dublin 2
Ireland
Tel. +353 1 661 3111
LoCall 1890 321 421
Fax +353 1 662 0283
e-mail duchas@indigo.ie

The Secretary,
Galway County Council,
P. O. Box No. 27,
Liosbán Retail Centre,
Tuam Road,
Galway.

Dear Sir/Madam,

Re: Planning application No. 97/3470 for permission for a wind farm with 23 wind turbines, service roadways, control house and anemometer mast at Boleyneendorrish and Derrybrien West, Co. Galway - Saorgus Energy Ltd.

Planning application No. 97/3652 for permission for a wind farm with 23 wind turbines, service roadways, control house and anemometer mast at Derrybrien North, Co. Galway Saorgus Energy Ltd.

I refer to your letters of 9th February, 1998 regarding the above mentioned applications.

The information provided in the EIS for these proposals was insufficient to allow for a proper assessment of the potential impacts of these developments on the nearby Lough Cutra Special Protection Area (SPA), for the protection of wild birds and their habitat, and on candidate Special Area of Conservation (SAC) No. 252, Coole-Garryland Complex.

There are potential negative impacts on these sites from peat silt emanating from the works and entering the catchment of these lakes. More specific information regarding mitigation measures to avoid siltation impacts is required.

Peat silt poses a threat to flora and fauna in the streams and rivers in the catchment of these developments. They should be checked for *Margaratifera margaratifera*, the Freshwater Pearl Mussel, a species which is protected under the Wildlife Act, 1976 and which is also listed on Annex 5 of the EU Habitats Directive.

We also require information regarding birds of prey, in particular Hen Harriers, in order to allow for a proper assessment of the potential impacts of these proposals on important EU Bird Directive Species, this to include more information on breeding versus migratory birds.

Until this information is received we will not be in a position to comment on these proposals.

Yours sincerely,

Patrick White
National Parks and Wildlife
11th March, 1998.

Our ref: Plan98

Dúchas The Heritage Service

The Secretary,
Galway County Council,
P. O. Box No. 27,
Liosban Retail Centre,
Tuam Road,
Galway.

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Yours sincerely,

Patrick White
National Parks and Wildlife
11th March, 1998.

An Roinn Ealaíon, Oidhreachta, Gaeltachta agus Oileán
Department of Arts, Heritage, Gaeltacht and the Islands

Dúchas
The Heritage Service

Rannóg na nIarratas Forbartha
Development Applications Section

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Glao Áitiúil 1890 474 847
E-mail devapps@ealga.ie
Web www.heritageireland.ie

Your Ref: PL 07. 122803
Our Ref: DAS-2000-GA-GA-00/4581

Secretary
An Bord Pleanála
Floor 3, Block 6
Irish Life Centre
Lower Abbey Street
Dublin 1

Re: Planning Application Reg. Ref. No. 00/4581 for an extension to Derrybrien wind farm consisting of 25 mast turbines, service roadways, transformer compounds and anemometry mast, and to increase the permitted hub height of 46 turbines to 60m and extend the permitted blade length of these turbines to 30m at Toormacnevin, Bohaboy, Derrybrien and Derrybrien North, Co. Galway - Saorgus Energy Ltd.

Dear Sir/Madam,

We refer to the Board's letter of 24 April 2001, and enclosures, regarding the above-proposed development. Due to a large increase in the number of planning and development referrals we were not in a position to meet your deadline and trust that our submission will be considered by the Board.

This Department had concerns, from the point of view of nature conservation in the area of the proposed development, with what is considered to be deficiencies in the Environmental Impact Assessment (EIA) submitted for the proposal. At the time of the application the Council had already made its decision before we were in a position to convey these to them. We therefore now wish to make the following comments.

While the EIA identifies the site as being suitable for Merlin and Hen Harriers, no survey was carried out to determine the presence of breeding birds. This is a significant deficiency and without it we cannot adequately judge the impact of the development on these birds. Both of these species are listed in Annex 1 of EU Birds Directive (Council Directive 79/409/EEC on the conservation of wild birds). A survey of Hen Harriers is considered to be of particular importance since there is suitable habitat in the vicinity and as the Slieve Aughties are known to be a stronghold for the species.

In order to protect Annexed bird species and their habitats it is considered necessary that further work on breeding raptors, be carried out during breeding season (Summer 2002). Until a complete survey of the area for breeding birds, using standard methodologies employed in the Hen Harrier Survey 1998/99, has been carried out and assessed by this Department we are unable to determine the extent of the impact of the proposed development on the protected birds.

Yours faithfully,

Joanna Modzelewska
Development Applications Section
20 September 2001