

Lewis Wind Power (LWP) Environmental Impact Statements (EIS) 2004 and 2006 - A Critical Review

Executive Summary

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(with a hydrological review annex by
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in the main report)

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EXECUTIVE SUMMARY

The present report has been commissioned from the University of East London Peatland Research Unit by the RSPB. This is in response to the proposal from Lewis Wind Power to construct a wind farm consisting of 181 turbines (originally 234 turbines), plus access roads and other associated infrastructure, within the Lewis Peatlands Special Protection Area (SPA).

The report consists of ten chapters and six appendices. One of these appendices has been provided by Dr Olivia Bragg, University of Dundee, and considers the details of a technical appendix presented by LWP as part of its revised development proposal set out in the LWP 2006 EIS documents. Other than Dr Bragg's contribution, the present report has been written by Mr Richard Lindsay, Head of Wildlife Conservation and the Peatland Research Unit at the University of East London, and Mr Jamie Freeman, Research Assistant within the UEL Peatland Research Unit.

The Executive Summary is set out below according to the chapters in the main body of the present report, and cross-referencing is provided to particular sections of the report to enable the reader to refer directly to the relevant text in the main report.

Chapter 1 : Introduction

The UEL Peatland Research Unit (PRU) was originally commissioned by the RSPB to provide comments on an EIS linked to a proposal by Lewis Wind Power to build 234 wind turbines within the Lewis Peatlands SPA. One of the present authors provided comments on this LWP 2004 EIS (Lindsay, 2005). Lewis Wind Power then submitted a revised proposal for 181 turbines and infrastructure, still largely within the Lewis Peatlands SPA, and so the RSPB commissioned the UEL PRU to examine the EIS accompanying this revised proposal. A number of issues emerged in the course of reviewing the original 2004 proposal, and were encountered again when looking at the LWP 2006 EIS for the revised proposal. To address these adequately, the UEL PRU undertook a period of fieldwork on Lewis in October 2006. An interim report was produced on the basis of this by the UEL PRU (Lindsay, 2007). The present report brings together into a single document the range of issues raised during review of the two LWP EIS documents, informed by the detailed field- and remote-sensing evidence gathered by the UEL PRU (Section 1.1).

A critique of the first two UEL PRU documents (Lindsay, 2005, 2007) has been produced by Dr Tom Dargie (Dargie 2007a, 2007b). Some errors have been highlighted by this critique and have been addressed in the present report. For the remainder, the issues raised are more matters of judgement or opinion. The present report has thus not been altered in the light of Dargie (2007a, 2007b), other than to correct errors and to provide brief points of clarification.

The present report is intended as a review of evidence presented by LWP within its three main EIS documents – LWP 2004 EIS, LWP 2005 Transmission Line Addendum (TLA), and LWP 2006 EIS. It attempts to judge the degree to which the LWP EIS documents adequately assess the potential impact of the proposed development on the peatland habitat. It is not intended as an alternative to the LWP

EIS documents, although some EIS work has been undertaken to highlight the consequences of adopting approaches that differ from those used by LWP.

Chapter 2 : General comments about the LWP EIS documents

Although an EIS is designed to aid the decision-making process, particularly in relation to potential environmental impacts arising from construction and operation of the proposed development, the LWP EIS documents do not provide some of the basic information needed to make such judgements. Thus (Section 2.1):

- there is no table that provides at least indicative dimensions for all elements of the infrastructure;
- no information is provided for possible impact-distances associated with construction of overhead power lines;
- peat depth data are missing for more than 7% of the road-line, and for the entire route of the overhead power lines.

An EIS is meant to provide as complete a view as possible of the environmental impacts likely to occur should the proposed development go ahead. Ecological responses and interactions mean that it is often important to consider worst-case events, and to consider them in an integrated way. However, the LWP ES documents tend to set out examples which are only appropriate for typical, or even best-case conditions (Sections 2.2, 2.3 and 2.4).

The 'uncertainty principle' is recognised as being a key part of environmental decision-making, and the LWP EIS documents do highlight some areas of uncertainty. Unfortunately such uncertainty tends to be provided within technical sections, and when the same information is presented in summary form elsewhere, the element of uncertainty is often lost – suggesting a certainty which does not in fact exist (Section 2.5).

An EIS should give confidence in its predictions and conclusions. This is normally achieved by using well-established methods and theories for assessing key issues. For a number of topics that are central to the assessment of character, condition and potential impact for the peatland habitat, the LWP EIS documents elect not to adopt this approach. They instead choose to develop their own methods that have not been validated through scientific peer-review, and embrace theories that are currently unproven (Sections 2.6 and 2.7).

Chapter 3 : Infrastructure

The LWP EIS documents refer to the need for the flexibility provided by micro-siting when deciding precisely where to place elements of infrastructure. Although micro-siting is generally assumed to result in a reduced environmental impact, this is not necessarily the case. What micro-siting undoubtedly does is increase the area that must be assessed for potential environmental impact (Section 3.1.1). Furthermore, the actual footprint of the LWP development could be increased by anywhere between 8.6% and 18.5% because a sinuous road covers more ground than a straight road, and turbines set back further from the access road require

longer connecting road sections (Sections 3.1.2 and 3.1.3). This issue is not addressed at all by the LWP EIS documents.

Furthermore, the flexibility of micrositing can only produce less environmental impact if all relevant environmental information is gathered and features of environmental significance are correctly identified. This appears not to have been the case in the LWP EIS documents, particularly in relation to peat depths, and recognitions of a major peatland type (Section 3.1.3). More will be said about both of these issues later.

Reference has already been made to the lack of basic, consistent information about the dimensions of the proposed infrastructure within the LWP EIS documents. This is considered in more detail in Section 3.2.

Chapter 4 : Construction

Section 4.1 : Roads

Four methods of construction are proposed for the (in effect) permanent road system required for the LWP development. One of these involves the upgrading of existing crofting tracks, and thus has little relevance to the peatland habitat. The remaining three methods, for use specifically on peat, are excavation, 'floating' roads, and rockfill.

LWP's own review of road construction methods for peat considers six different methods, including piling and pre-loading, but does not consider rockfill at all. Of the methods considered, only piling and excavation are identified as definitely providing the necessary functionality. Piling is not then mentioned further, and excavation is considered only for areas of thin peat.

The favoured methods for deeper peat are thus rockfill – for which no evaluation of functionality is given – and 'floating' roads. This latter method is identified as having many disadvantages and is assessed with a rather lukewarm "for consideration where it meets functionality", yet this construction method will be used on 70% of the road network. No supporting scientific literature is cited in relation to either rockfill or 'floating' roads. This is because very little has been published about the long-term behaviour and environmental impact of such methods. In short, in environmental terms these selected construction methods are best described as 'experimental' (Section 4.1.1).

What published scientific literature there is about roads constructed over peat makes clear that both short- and long-term subsidence is almost inevitable, and this will occur to different degrees and at different rates along a road length. This variable subsidence tends to have significant operational and environmental consequences (Section 4.1.2). These issues are not mentioned or addressed by the LWP EIS documents.

There are also significant concerns in relation to the use of rockfill roads on the deepest, wettest peats, as proposed by the LWP EIS documents. Loading of substantial quantities of rock directly into the peat surface in a very wet peatland is likely to have significant implications for slope stability and peatslide risk (Section 4.1.3). This possibility is neither acknowledged nor discussed in the LWP EIS documents.

The assumption that 'floating' roads require no side-drainage means that the LWP EIS documents do not consider the potential environmental effects of such drainage. Where the roads do sink, fresh road material will be needed and drainage will be required to keep them operational but the impact of this drainage on water management and sediment control is not addressed (Section 4.1.5.1).

Section 4.2 : Turbines

It is acknowledged by the LWP EIS documents that there is a degree of uncertainty about the geotechnical character of the peat to be excavated from turbine locations. Consequently it is proposed that some trial excavations be undertaken from a variety of 'typical' ground conditions to reveal more of these geotechnical issues. The six listed trial pits do not in fact lie in 'typical' ground, but are all located in highly atypical conditions. The value of this exercise is thus highly questionable (Section 4.2.1).

Although certain aspects of the methods to be used for construction of turbine bases remain obscure (Section 4.2.2), a potentially more serious issue concerns drainage and treatment of discharge water from the turbine excavations. Several stages of water control and treatment are described in the LWP EIS documents, but it seems that the finest suspended materials can only be removed by flocculation. The environmental implications for this, especially in terms of public water supplies, are not mentioned at all (Section 4.2.3).

Section 4.3 : Power lines

Although some sections of the power lines will be buried beneath or alongside the windfarm roads, slightly more than 30 km of power lines will be constructed as overhead transmission lines, carried on pylons, and will not follow the line of windfarm roads. In order to construct the pylons and install the transmission lines, it will be necessary to construct a temporary access road along a route which is almost entirely dominated by blanket bog.

The LWP EIS documents contend that, because the roadway is only temporary and the transmission lines are strung at some height above the ground, there will be virtually no environmental impact to the peatland. However, the LWP documents also acknowledge that the ground is often very eroded and uneven, and so it will be necessary to 'level' the route of the temporary road surface. Such levelling involves digging out sections of peat which, once removed, cannot be satisfactorily replaced (Section 4.3.2.3).

In addition, the transmission-line route crosses a number of pool systems and other forms of very difficult ground. The route for the vehicles will necessarily be obliged to find a more circuitous route than that finally followed by the transmission lines, thereby adding significantly to the length of this temporary roadway.

The lack of any peat-depth data for the route of the overhead transmission lines also makes it difficult to assess potential impacts caused by either the roadway or by excavation for the pylon bases. The LWP EIS documents predict that any impact from construction of the power lines will show rapid reversion to pre-existing conditions. Consequently the transmission lines and their pylons do not appear at all in the tables of environmental impacts. This view is either highly optimistic or just simply incorrect. It is more likely that at least some sections of this 'temporary' roadway will be visible for some years to come.

Chapter 5 : Geology, hydrogeology and drainage

Section 5.1 : Peat depths

It has already been mentioned that peat-depth data are missing for around 7.5% of the development roadline and for 100% of the overhead transmission lines. For those wishing to assess the accuracy of LWP EIS predictions in relation to the peatland habitat, the position is even worse because the peat-depth data that *are* supplied as part of the LWP EIS can be interpreted with only the greatest difficulty, and in some cases the data cannot be read at all. Given the fundamental importance of such a dataset to the assessment process on this site, such a failure to provide clearer data (even after repeated requests) represents a major consultative failing on the part of LWP (Section 5.1).

Section 5.2 : Description and classification of peatland systems

Given that blanket mire peatland dominates at least 85% of the development area, an assessment of potential habitat impacts very much depends on the adoption of classification systems that are capable of describing the biological diversity and ecological functioning of the blanket mire environment. A great many such systems exist. It is therefore most unfortunate that the LWP EIS documents choose not to use any of these and instead devise their own system of description and classification (Sections 5.2.1 – 5.2.6).

The LWP approach begins badly by using catchments as the largest mapping unit, apparently in the mistaken belief that catchments are recommended for such peatlands by the Ramsar Convention, whereas in fact the Ramsar guidance merely states that catchments should be used for peatlands ‘where appropriate’. Catchments are not appropriate units of description for blanket mire peatlands (Section 5.2.1).

A long-established system of classification entirely appropriate to blanket mire systems, and indeed to all mire ecosystems, forms the basis of official guidance to the UK conservation agencies (Section 5.2.1 – 5.2.5). This same system has been employed in various forms since the early 1980s in many parts of the world, and now features in Ramsar Convention guidance for peatlands (Section 5.2.1.1).

The LWP EIS documents acknowledge the existence of this classification system, but then explicitly choose not to use it, preferring instead to devise a novel system based on Erosion Class, specifically designed to describe the features observed by LWP in the Lewis Peatlands. The system developed by LWP has its origins in the description of erosion from the early 1960s, but that was for research into the nature of erosion. By explicitly putting erosion at the heart of its descriptive system, LWP has thereby devised a system that is capable of describing and assessing states of erosion, but is a very poor system for describing blanket bog in any other state – particularly relatively wet, undamaged mire, or mire showing vigorous vegetation recovery (Section 5.2.5).

Furthermore, close examination of the LWP mapping units for these Erosion Classes reveals that the mapping system used often results, within any particular Erosion Class polygon, in the inclusion of significant areas that clearly do not form part of that particular Erosion Class. Consequently the area calculations made for Erosion Classes must be regarded as indicative only, but it also often means that less-eroded or un-eroded ground is overlooked in this way (Section 5.2.5.2) and is thus perceived to be rarer than it is. Field survey by the UEL PRU confirmed this finding, as is discussed later in this summary.

The present UEL PRU report gives a demonstration of how the established hydromorphological system of mire classification can be used to describe the blanket mire habitat of the Lewis peatlands in terms of its eco-hydrological character and function (Sections 5.2.2 – 5.2.4).

The other classification unit devised for the LWP EIA – namely Hydrological Zones - is one that has no real basis in any existing peatland literature (Section 5.2.6). The four identified zone types are defined on the basis of an amalgam of landscape and hydrological features, but precisely how these are translated into boundaries on the ground is never made clear. Indeed examination of how these boundaries lie within the landscape merely adds to the confusion (Section 5.2.6.1). Correlation of these Hydrological Zones with both the hydromorphological classification system and with LWP's Erosion Classes reveals a similarly poor linkage (Section 5.2.6.2).

The already-weak value of these Hydrological Zones is further undermined by the fact that they do not feature at all in the LWP EIS Habitats Chapter, and were thus presumably not considered helpful. The fact that these zones then play such a major role in assessing potential impact is an issue of very great concern.

A somewhat converse circumstance arose from the UEL PRU field survey in 2006, because an important type of peatland system – ladder fen/eccentric mire - was found to occur widely within the LWP development area, but this type was completely overlooked in the LWP EIS documents and features only obliquely in the original LWP Habitat Survey. In all, a total of some 25 such sites were found to lie adjacent to or on the actual line of the proposed LWP development (Section 5.2.7.3). These are significant partly because they are considered to be of very high conservation value (they are listed by the JNCC as examples of 'active blanket bog' for the purposes of the EU Habitats Directive), but their very wet nature also means that they pose significant engineering challenges. Unfortunately in some cases, major elements of the LWP development infrastructure are proposed for such areas (Section 5.2.7.4).

Section 5.3 : Causes and significance of erosion

The LWP EIS documents suggest very strongly and repeatedly that the blanket mires of Lewis are undergoing erosion of an atypical kind and as a result are also unusually dry within the British context. The northern part of Lewis is described as one of the most severely eroded peatlands in Britain. It is, however, difficult to find published evidence supporting this proposition. Indeed evidence of much more severe erosion elsewhere in Britain is relatively easy to find (Section 5.3.1).

The LWP EIS documents provide a remarkably detailed description of a de-watering process associated with the development of underground 'peat-pipes'. While the description provided by the LWP EIS documents is extremely detailed, it is also extremely difficult to find any published evidence documenting this process. Certainly the LWP EIS documents provide no supporting evidence for this process on Lewis (Section 5.3.3). Nonetheless this de-watering process is used repeatedly to explain the claimed 'atypically' dry and eroded nature of the Lewis peatlands (Section 5.3.4). This is in marked contrast with the conclusions of an SNH survey of the adjacent SAC, where erosion and drying are attributed to the effects of burning.

While the LWP EIS documents provide no evidence for the peat-pipe and de-watering sequence, the present report offers some evidence that, while peat pipes are undoubtedly common in the Lewis peatlands, and elsewhere, they may not

necessarily always be the 'destructive' features so strongly suggested (though not demonstrated) by the LWP EIS documents. This UEL evidence is based on the UEL PRU fieldwork and remote-sensing work carried out on Lewis, but also on fieldwork undertaken elsewhere in Britain (Section 5.3.5).

Section 5.4 : Eco-hydrology of peatlands and peatland drainage

The main evidence presented in the LWP 2006 EIS for potential eco-hydrological impacts resulting from the LWP development, are the results obtained from a hydrological study at Farr Wind Farm, which is a wind farm built on blanket peat during 2005 and 2006. This hydrological study is assessed and discussed in detail by Dr Olivia Bragg in Appendix 1 of the present report. Essentially, her conclusions are that the results obtained from the Farr Wind Farm study cannot adequately sustain the limited zone of environmental impact claimed by the LWP EIS documents (see Appendix 1 and Section 5.4.7 of the present report).

This chapter begins with a section that looks at measurements of moisture content taken by LWP from some drained peat. These are claimed to show that drainage has hardly altered the moisture content at all. In fact these measurements show no such thing, in part because no figures are provided for moisture contents prior to drainage, and also because all the moisture values given are much lower than LWP's own figures for typical moisture contents of Lewis peat (Section 5.4.1).

The present report then looks at the mechanisms of peatland drainage, firstly in the lower catotelm of the peat, then in the surface acrotelm zone (Sections 5.4.2 and 5.4.3). The LWP claim (in part supported by the results from Farr Wind Farm, or so LWP believes) that drainage only affects peatlands over distances of a few metres is shown to be sometimes true in the lower catotelm layer, and that in peatlands this is often referred to as the 'groundwater' layer.

However, the living surface depends on the water-table behaviour in the upper acrotelm layer, and the present report makes clear that the various authorities cited by the LWP EIS documents all agree that drainage has its main, and often extensive, impact in this layer (Section 5.4.3). Measurable drainage impacts in this layer are acknowledged by these authors to be capable of extending beyond 50 m. The present report also presents evidence suggesting such change across a distance of 80 m and possibly further.

A review of Gilman's '50 metre zone', referred to by both LWP and SNH as a safe buffer distance, reveals that in fact Gilman identifies the possibility of change in even groundwater levels (i.e. the catotelm) and in the peat profile itself due to slumping and oxidation, over distances greater than 50 m. If the underlying catotelm changes over this distance, acrotelm effects are likely to extend further than this (Sections 5.4.4 and 5.4.5).

The LWP EIS documents give very precise details of how de-watering caused by peat pipes and gully erosion can produce very large areas of such dry peatland that there is considered (by LWP) to be little or no active peat formation. Given that a gully is in effect a drain, it is not easy to reconcile this description with the assertion that drainage impacts would only be felt across distances of 2.5 m or so (Section 5.4.6).

Section 5.5 : Water crossings

This chapter then closes with a review of the proposed strategies within the LWP development for managing crossing points where water must pass over, under or through the windfarm roadline. Several formal water crossings are identified by the LWP EIS documents, and it is stated that special structures will be put in place here. There is also a commitment to provide a water crossing wherever the roadline crosses a water channel. Given the very large number of erosion gullies that must be crossed by the roadline, and the complexity of channels associated with some of the proposed water crossings, it is not at all clear how the system of formal crossings will work. In addition, settlement ponds are regarded as unsafe for the dominant Hydrological Zone, so this raises the question of how so many potential water crossings will be supplied and maintained with technology such as Siltbusters® (Section 5.5).

Chapter 6 : Habitats

Section 6.1 : A mire landscape of international significance

This chapter of the present report begins by emphasising the international significance of the Lewis peatlands in terms of the types of mire systems found here, but also the fact that the LWP development proposals lie almost entirely within the boundaries of two international conservation designations – SPA and Ramsar.

Section 6.2 : Perceptions of the Lewis peatlands

This section of the present report examines the assertion made by the LWP EIS documents that the Lewis peatlands are undergoing a progressive degradation sequence linked to peat-pipe collapse, initiation of erosion, and associated drying of the blanket bog environment. The two key issues here are that LWP considers this degradation sequence to be a natural process, and that this degraded, eroded bog is of low conservation value. There is an inconsistency in the logic here, because *if* erosion is a natural process then eroding bog (and all the sequences of erosion) are of conservation value. This would be particularly so if the process on Lewis were in some way unusual. The possibility that erosion is instead caused by burning is dismissed by the LWP EIS documents (Section 6.2.3).

Section 6.3 : Peatland, erosion and burning

This section begins by reviewing a range of published literature concerning the possible origins of the extensive blanket mire that is found in so much of this habitat across Britain and Ireland. The LWP EIS documents do not explore any of this literature, apparently because burning is regarded as only a minor, rather transient factor in the dynamics of the Lewis peatlands (Section 6.3.1)

The present document then examines a range of evidence gathered from a variety of sources and from UEL PRU field survey concerning the relatively recent record of fire in northern parts of the Lewis peatlands. This evidence highlights both the relatively common nature of burning even today (with one very recent fire being found by the UEL PRU within the SAC), and the marked evidence of fire damage which was also often associated with significant erosion and surface breakdown. The review also identifies the fact that the LWP Habitat Survey recorded relatively limited signs of burning damage, though sometimes the recording of such damage appears to depend more on the individual surveyor than on the evidence on the ground – in effect, the same ground described by two LWP surveyors is recorded as having

evident fire damage by one surveyor, but no signs of burning by the other surveyor (Section 6.3.1).

The significance of fire in explaining the present condition of the Lewis peatlands is then explored, and consideration is given to the recovery rates likely in this area if an area of the bog is damaged by fire. It concludes that recovery times for fire-induced erosion to infill the resulting gullies are likely to be in the order of 200 years at least, but may be very much longer than this. Meanwhile, the LWP EIS documents conclude that burning is not a major factor because SNH has had a Peatland Management Scheme in place for the last decade and this will have reduced incidences of burning. The fact that a major fire occurred in 2003, and the UEL PRU found a substantial fire in 2006, suggests that this confidence is misplaced. It also does not allow for the recovery timescales discussed above (Section 6.3.2).

Section 6.4 : Vegetation of Lewis peatlands

It is the contention of the LWP EIS documents that the Lewis peatlands are dominated by dry peat which supports much dry heath vegetation, particularly consisting of the NVC type H10b. It is worth noting at this early juncture that an SNH survey found no H10b on the peat of the adjoining SAC. The LWP EIS documents state that the (experienced) SNH surveyor had overlooked this vegetation type (Section 6.4.1).

For its part, the LWP Habitat Survey decided early on to separate out a bell heather (*Erica cinerea*)-rich peatland vegetation type as H10b. This is then justified by citing various vegetation accounts, including a paper by one of the present authors, and suggesting that these accounts justify the separation of this vegetation into a dry heath type. This is not the case – these cited papers do not support such a decision (Section 6.4.1.1).

The present report consequently reviews the phytosociological (plant sociology) principles that underpin the National Vegetation Classification (NVC) and thereby identifies that much (though not all) of the vegetation data assigned by the LWP EIS documents to a dry heath H10b NVC type instead fits more comfortably in a blanket mire vegetation type (Section 6.4.1.2).

In the course of explaining this re-assessment of dry heath types in an earlier response to the LWP EIS documents (Lindsay 2007), one of the present authors incorrectly quoted two well-respected vegetation surveyors, Ben and Alison Averis. This was a serious error and the present author has apologised unreservedly for this. However, as a consequence of this, the Averis's were invited by LWP to re-analyse the LWP Habitat Survey data. The result is that the Averis's identify only a small proportion of 'H10b' quadrats as that type, and suggest that the others are either mixtures or blanket mire vegetation types. The proportions they suggest for re-assignment amount to the same proportions identified by Lindsay (2007). Fieldwork by the UEL PRU has also found that areas on the ground described as being dominated by H10b are actually much richer in blanket mire vegetation than suggested by the LWP Habitat Survey dataset (Section 6.4.1.3).

Indeed the methodology used by the LWP Habitat Survey is one that is extremely difficult, if not impossible, to implement in any consistent and meaningful way. The present report highlights the practical difficulties of undertaking such quantitative survey, and suggests that, once again, any numbers obtained from such work can be regarded as merely indicative, at best (Section 6.4.2).

An alternative approach to such vegetation description, based on the hydromorphological classification system in the JNCC guidelines for this habitat, is presented in the present report as an example of the way in which a complex and highly heterogeneous vegetation pattern can be summarised quite quickly and effectively. Quadrat data obtained during the UEL PRU fieldwork are used to illustrate this (Section 6.4.2.2 and 6.4.2.3).

Section 6.5 : 'Active blanket bog' within the development area

This section of the present report begins with a review of the official definitions for 'active blanket bog' in relation to the EU Habitats Directive (Section 6.5.1).

The approach adopted by the LWP EIS documents to defining 'active blanket bog' is then reviewed. However, as LWP does not have the authority unilaterally to revise the official definition of this term, the extensive exercise undertaken by LWP to this end is, alas, irrelevant (Section 6.5.2).

The present authors attempt to provide an estimate for 'active blanket bog' based on the official definition and the data provided by the LWP Habitat Survey, although this is undertaken in the knowledge that there are significant concerns about the quantitative nature of the LWP Habitat Survey dataset. This exercise produces a very cautious estimate for the extent of active blanket mire in the LWP habitat Survey Area (HSA). This estimate amounts to just over 21,000 ha, which is approximately three times the area calculated by LWP using its particular definition of 'active blanket bog' (Section 6.5.2.4).

Chapter 7 : Peatslide Risk Assessment

This chapter of the present report begins by observing that there have been two very substantial peatslides, and something of a flurry of publications about peatslides and peatslide risk in the last three or four years. Two of the most substantial and relevant of these documents to have been published – one about peatslides in Irish blanket mires and the other about peatslides in the Pennines of northern England - are not referred to. Consequently the implications of these documents are not considered within the LWP EIS documents, which is to be regretted.

Section 7.1 : The LWP approach to peatslide risk assessment

The LWP EIS documents firstly consider the information needed to assess whether there are any localities that may be at risk of a peatslide. This involves gathering information about the physical nature of the peat, in particular California Bearing Ratio (CBR) data, along the length of the proposed roadline.

However, the present report points out that no field data appear to have been gathered since 2004 although significant parts of the proposed infrastructure layout have been altered since then. It also points out that the extensive LWP CBR dataset is neither presented nor discussed. The only tangible result of this fieldwork is a map that shows a number of locations where there may be soft sub-peat strata. However, not only is this map not then discussed, it is never actually mentioned in any of the LWP EIS texts. Thus the CBR data are never presented, and their sole tangible output is never discussed (Section 7.1.1 and 7.1.2).

This lack of information about the Mexe Probe CBR data is a great shame because the present report then illustrates the degree to which the peat body of the Lewis peatlands generally contains distinct and sometimes highly complex layering of peat. This layering should have been obvious in the Mexe Probe CBR data, but this information is not provided by the LWP EIS documents (Section 7.1.2).

The present report then considers the approach adopted by the LWP EIS documents to slope stability analysis, by which areas of (particularly soft) sloping ground are assessed for their likelihood of slope failure – *i.e.* of becoming a landslide. This work is somewhat shrouded in ambiguity because it is not made clear what data were used to undertake such an analysis. Furthermore, only a single analysis of slope stability is presented, for a site near Loch Bhatandip (Section 7.1.3.3). More such analyses may have been undertaken, but there is no clear evidence of this.

Consequently a development extending over more than 140 km of a peat-dominated landscape may have been subject to only a single slope-stability analysis. Furthermore, this analysis generated Factor of Safety (FoS) values that give rise to considerable concern. The present report explains that FoS values below 1.4 are generally considered to be at increasing risk of slope failure, and it also illustrates the way in which raised water tables give rise to low FoS values (Section 7.1.3).

The single FoS example given by the LWP EIS documents is calculated by LWP to have an acceptable value of FoS when the bog water-table is 1 m below the peat surface but has a wholly unacceptable value (0.75 – *i.e.* a failed slope) when the water table is at the bog surface. The present report points out that using a water table at 1 m beneath the peat surface to calculate a FoS is unrealistic, because LWP itself has elsewhere acknowledged that even extreme water-table draw-down into blanket peat is generally no greater than 40 – 50 cm, whereas the normal range lies within 10 – 20 cm of the surface. The present report gives two graphs demonstrating the fact that if the water table lies within its normal range, FoS values for much of the Lewis peatlands are likely to be fairly close to the threshold of safety. This is significant not because most peat slopes are naturally about to fail, but because slopes with such low natural values are likely to be extremely susceptible to any form of disturbance (Section 7.1.3.3).

Having said all this, the LWP EIS documents do not make it at all clear how its slope stability analysis work contributes to the LWP EIA assessment.

The LWP EIS documents next describe a process of peat-slide hazard mapping. This work involves a peat-slide inventory (for which almost no information is provided), geomorphological mapping, peat-slide susceptibility mapping (again, little information is provided), avalanche corridor mapping (again, no information is provided), and visits to other windfarm sites (which are not then discussed in any way). The peat-slide susceptibility mapping is described as being based on the UNESCO-recommended approach set out by Varnes (1984). The present report points to the very stark difference between what is offered by the LWP EIS documents and the susceptibility maps presented by Varnes (1984), before using LWP's own Habitat Survey data to demonstrate how such an informative peat-slide susceptibility map could have been generated (Section 7.1.4.5).

Section 7.2 : Peat-slide incidents – lessons from elsewhere

This section of the present report considers what can be learned from experience and research involving peat-slide incidents elsewhere. A number of very relevant issues emerge from this review, but few, if any, of these issues are addressed in the

LWP EIS documents. Perhaps the most important single factor to emerge from this review is the fact that zones of seepage are regarded as being particularly susceptible to slope failure if disrupted. Such a zone of seepage is implicated as one of the factors contributing to the enormous bogslide at Derrybrien Wind farm, Co. Galway. The issue of seepage zones is particularly significant because ladder fens, so far un-recognised and un-reported by LWP, are significant zones of seepage.

Section 7.3 : LWP Peatslide Risk Assessment

The LWP peatslide risk assessment identifies what it describes as only 15 localities within the development area where there is any possibility of slope failure. Given the various factors discussed above, this is a difficult claim to accept. Nonetheless, the LWP EIS documents proceed to describe actions to be taken to prevent slope-failure at these 15 sites. Given the prevailing ground conditions, particularly the presence of ladder fens, wet percolation mires, seepage zones, many of the solutions proposed by LWP are simply not appropriate and may cause more harm than good. Each locality is discussed in some detail in the present report.

Section 7.4 : Implications for peat stability at the LWP windfarm

Given the somewhat unsatisfactory treatment of peatslide risk by the LWP EIS documents, as described above, the UEL PRU undertook its own assessment of peatslide risk, employing the same parameters used by LWP, but combining these with parameters used in an assessment of peatslide risk in Ireland, undertaken by the Landslides Working Group of Ireland. The parameters used are given in Section 7.4.1.1 of the present report.

The outcome from the UEL PRU analysis of potential 'at-risk' sites is that a total of 97 such localities were identified – almost three times the total maximum number of sites initially identified by the LWP EIS documents (Section 7.4.1.2).

Section 7.5 : Engineering and real-world construction

This chapter of the present report ends with a review of the engineering process, and the fact that while well-established engineering processes such as house construction rarely lead to structural failure, engineering projects involving new approaches and untested techniques could be said almost to rely on failure as a means of identifying which aspects of this novel approach work, and which don't. This is highly relevant to questions of relatively novel engineering such as, for example, 'floating' roads and rockfill construction in wet deep peat, as proposed for the LWP development.

Chapter 8 : Direct and Indirect Impact Assessment

This chapter of the present report begins by emphasising the highly variable nature of the ground within the Lewis peatlands, and the consequent problems of attempting to provide a single width of 'potential impact zone' for such ground. It highlights the very real difficulties associated with the LWP EIS assertion that most impacts will be restricted to a 2 m zone bordering the development.

Section 8.2 : UEL impact assessment

In this section of the present report, a possible alternative approach to the LWP method of impact assessment is presented. It firstly identifies all ground directly affected by the proposed LWP infrastructure (Section 8.2.4). It then highlights the fact that micro-siting flexibility expands the potential area which must be assessed in terms of its environmental value and potential for disruption. Looking, then, within this 'area of search', ground was assessed using several criteria (such as presence of ladder fen, or evidence of peat pipes). From this, a total of 199 'areas of hydrological concern' were identified. Every one of the 97 sites already identified as being at risk of slope failure was included within this list of 199 areas of hydrological concern (Section 8.2.6).

These 199 areas were then examined in more detail using field survey data and remote-sensing information to identify an appropriate potential area of impact, referred to as a 'Zone of Concern' (ZoC). In drawing up these boundaries, several sites became amalgamated. Thus from the original 199 sites, a total of 76 ZoCs were generated (Section 8.2.7).

Consideration then turns from specific localities with evident issues to the general degree of indirect impact likely to be associated with all elements of the proposed LWP infrastructure. A review of acrotelm dynamics (Section 8.2.8.1 to 8.2.8.3) emphasises the very real potential for general impacts to be felt as far as 50 m away from the development.

Consequently the map of total infrastructure is then provided with a 50 m buffer zone, to create a general potential zone of impact (GPZI). The resulting impact areas are then summarised thus (Section 8.2.8.4):

Direct loss to infrastructure	=	555 ha
Total area of GPZI	=	2,625 ha
Total are of GPZI and ZoCs	=	3,154 ha

Thus the area of potential impact so far identified is 3.5 times larger than the 901 ha total 'realistic' area of impact proposed by the LWP EIS documents.

The present report then considers the potential impacts resulting from breakdown of the bog surface pattern, or even of a bogslide, and assembles a set of impact zones where the size of zone is determined by the depth of peat. This creates a set of Mesotope-Microtope Zones of Concern (MZoCs) (Section 8.2.9), which are then combined with the GPZI and ZoCs described above. This produces a total UEL Potential Zone of Impact (UEL PZI) of 5,569 ha, which is slightly more than 6-times larger than the 901 ha proposed as a 'realistic' impact zone by the LWP EIS documents.

Section 8.3 : Impact on 'active' blanket bog

The present report next considers the extent to which the UEL PZI supports 'active blanket bog'. Using the definition of 'active blanket bog' assembled in Section 6.5 and overlaying it onto the UEL PZI boundary, it seems that the UEL PZI contains 4,808 ha of 'active blanket bog', compared to 202 ha loss predicted by the LWP EIS documents.

Section 8.4: Loch Mor an Starr

Finally, this chapter of the present report considers the implications of infrastructural development and potential impact in relation to the public water supply of Loch Mor an Starr. The LWP EIS documents attempt to provide complete reassurance that this water supply will not be affected by the LWP development.

However, issues associated with construction of the overhead transmission lines, which will actually cross the head of the loch and then run along the shoreline, and the presence of several features such as ladder fens and seepage zones along the proposed route of the roadline, suggest that LWP should not be so sanguine about the potential dangers.

Furthermore, when questioned about the possibilities of pollution or sedimentation into the loch, the LWP EIS documents quote the very low rates of water (and thus pollutant) flow associated with catotelm peat. The fact is, such pollutants and sediment loads will be moved along by overland and near-surface flow. Such flow can achieve speeds of more than 800 metres per day, compared with the 15 metres per year cited by the LWP EIS documents (Section 8.4.3).

Section 8.4.4 of the present report considers the potential for slope failure in the deep peat that lies alongside the western shores of Loch Mor an Starr. The landslide hazard criteria used as part of the LWP EIA are applied to this area of deep peat, and it seems that there may be reason for concern should the roadline and power line be constructed along the proposed routes.

Chapter 9 : Cumulative Effects and Impact Interactions

This chapter looking at potential impacts arising from the LWP proposals considers the questions of hazard and risk. The former is defined as the potential for an impact to occur (Section 9.1.1), while 'risk' is defined as the consequences of such an impact, particularly in terms of cost (Section 9.1.2).

These issues are explored further in Sections 9.1.3 and 9.1.4, and are presented in terms of the potential geographical consequences should a major peatslide occur and enter a river system. The sites considered by the UEL PRU earlier to be at risk of slope failure form the sites of initiation, but then landform maps are used to identify which parts of the landscape and which river system would be affected.

The present report highlights the fact that the LWP EIS documents neither discuss the possibility of any such events and their consequences, nether do they attempt any assessment of the economic consequences of a peatslide occurring within the development area. Given the considerable economic consequences of the very large bogslide that occurred at Derrybrien, Co. Galway, it would seem both a highly pertinent analysis and one that could draw on the lessons learned from the Derrybrien incident.