APPENDIX A14.4

ESTIMATED PEAT EXTRACTION AND REUSE VOLUMES

viking energy
Harnessing Shetland's natural resources

Waste & Environmental Solutions

Viking Wind Farm

ES Addendum
Appendix A14.4

Estimated Peat Extraction
And
Re-use Volumes

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SECTION 1.0 INTRODUCTION

1.1 Context, Aims and Objectives

This report forms Appendix A14.4 of the Addendum Environmental Statement (ES) for the Viking Wind Farm and follows on from the original Appendix 14.4 provided in the 2009 ES.

The original Appendix 14.4 provided an initial review of the anticipated peat extraction and estimates of reuse volumes and investigated the feasibility of a range of potential reuse activities for excavated peat. Both onsite and offsite uses were investigated, however it was concluded that reuse of all excavated materials on site is the best option taking into account all environmental, practicality / feasibility, sustainability, safety and economical factors.

The Scottish Environment Protection Agency (SEPA) provided a detailed response to the original Appendix 14.4 and maintained an objection to the scheme provisional upon further clarification on the intended methods for dealing with excavated materials and waste management.

Subsequent to the 2009 ES being submitted, the wind farm layout has been amended in order to address the consultation responses from various statutory and non-statutory bodies relating to a wide range of issues. This report has been prepared as part of the design review process for amending the wind farm layout and to provide a re-assessment of the opportunities for minimising peat extraction and encouraging reuse, including revised estimates of excavation and reuse volumes. This report also aims to explore in more detail the preferred option of reusing all excavated materials on site as recommended in the original Appendix 14.4.

The primary objectives of the report are to:

- review the volumes of excavated materials and potential reuse volume requirements (in light of the revised wind farm layout) to determine whether there is likely to be negative or positive overall peat balance, whether the generation of waste materials will be avoided, and, if not, where reductions in the volumes of excavated materials may be achieved; and

- explore the sensitivity of the parameters used in the volume calculations to inform and refine proposed mitigation and good construction practices as detailed within the revised ES Addendum Technical Appendix A14.6, Site Environmental Management Plan (SEMP);

This report should be read in conjunction with the SEMP, which defines proposed good construction practices for the site as well as specific actions required to implement mitigation requirements as identified in the Environmental Statement (ES), the planning process and/or other licensing or consenting processes. The conclusions of this report, and in particular the peat volumes were taken into account in refining the SEMP, in particular the Site Waste Management Plan (TS3) and the Excavated Materials and Reinstatement Plan (TS7). The volume estimates have also been considered as part of the revised carbon payback assessment in the air and climate chapter of the Addendum ES.

1.2 Method

The EIA regulations and PAN 58 emphasise that elimination of adverse environmental impacts is at the heart of the EIA process. In designing the Viking Wind Farm in the 2009 ES and the 2010 addendum, one of the primary drivers was to minimise the impacts associated with excavation and disturbance of peat by using the hierarchy below (this approach also reflects the waste hierarchy included within the revised 2010 Waste Framework Directive):

- Prevent
- Reduce
- Reuse
- Offset

1.2.1 Prevent

In keeping with the EIA regulations, the original 2009 ES layout was designed to minimise the amount of excavated peat while still taking into account other constraints such as ornithology, hydrology, noise, engineering requirements, traffic impact and many more site constraints. To minimise the amount of disturbance, the design team identified the areas of deepest peat and tried to avoid these areas where possible when laying out the tracks and turbine bases. The design was informed by a mixture of site investigation:- probing, desk top study of aerial photography as well as local knowledge and walking all of the proposed track and turbine locations. This culminated in draft reports and discussions with the relevant agencies and other experts before the final design was produced. Peat slide risk assessment and further engineering advice also informed the finalised 2009 ES layout and subsequent submission.

The addendum has incorporated further design changes in order to further prevent direct impacts on peat land. The most obvious way to prevent impacts upon peat is by reducing the number of turbines and the lengths of track, thereby avoiding construction altogether in certain areas. Another way would be to make changes in the proposed methods of construction. The Viking project team has looked at the site again and determined a revised scheme layout that beneficially addresses all environmental constraints as identified in the 2009 ES and as raised by the consultees in their consultation responses to the 2009 ES.

1.2.2 Reduce

The amount of peat excavated from tracks depends on the final design i.e. cut or floating. The parameters of the design that were considered were the widths of tracks, the use of cut and fill tracks in certain depths of in-situ peat and track drainage details. The design team has tried to minimise further the amount of peat excavated by proposing floating tracks wherever possible. In the design review the track widths were also looked at again and it was agreed to reduce the double track widths from 12m to 10m. It was also agreed that the option of reinstating the double tracks to single track width upon completion of construction would further reduce the visual impact and reinstate some ecologically beneficial habitat, providing that sufficient excavated material is available for this purpose.

1.2.3 Re-Use

This report considers the estimated peat volumes required for the different areas where the peat is expected to be used in reinstatement activities, for example at turbine bases, hardstandings, tracks, verges, construction compounds and borrow pits. Further information on where reinstatement is required and good practice is provided in SEMP TS7 Excavated Materials and Reinstatement Plan. Figures A14.16 (a-m) also illustrate broadly indicative restoration profiles of the borrow pits.

The report demonstrates how changes in design or construction practices might influence the overall materials balance. For instance, the amount of peat used for the restoration of the bases, hardstandings, borrow pits and construction compounds may remain relatively fixed, whereas the design of the tracks is likely to have a significant impact on the amount of peat reused.

In addition to this, current best practice methods for excavation and handling of the material have been reviewed in order to determine whether the generation of waste materials will be avoided in the first place and where reductions in the volumes of excavated materials may be achieved and potential waste materials may be reused.

1.2.4 Offset

The Habitat Management Plan (HMP) (Appendix A10.9 of the Addendum ES) aims to off set any significant impacts that the proposed development may have. For peat impacts, the HMP aims to improve areas of blanket bog to try to stem and, if possible, reverse the deterioration of the peat lands which are in a poor condition in many places across the wind farm site and beyond. The HMP will not limit itself to the wind farm area and one of the aims of the addendum HMP is to increase its reach and therefore effectiveness.

1.3 Limitations

The preliminary excavation and reuse volume estimates provided in this report are indicative and are only provided as very broad estimates based on assumed design parameters for the entire site; ultimately localised variations in topography and infrastructure design will determine where and how much peat is required for use at a particular point. Every effort has been made to avoid and reduce the excavation of peat so far in the design process. Once detailed ground investigations have been undertaken (post-consent) at the detailed design stage, further opportunities for reducing peat impacts will be considered and potentially achieved. However, in some cases the amount of peat excavated from the turbine bases and permanent and temporary hardstandings may not be reduced further due to localised engineering constraints. Similarly, the tracks and bases need to be of a certain size to construct the scheme safely and efficiently.

The assessment of peat impacts is an evolving and iterative process that does not end at the completion of the ES or upon planning consent. The SEMP will form part of a formal contract between the Employer and the Contractor, and it is this plan which will provide the mechanism for ensuring that the Contractor continually assesses peat impacts (through avoidance, reduction and careful reuse of excavated peat) throughout the construction phase. The good practice measures specified within the SEMP are also in line with all current legislation and guidance relating to pollution prevention, habitats and species protection and waste management.

SECTION 2.0 GENERAL PRINCIPLES

Design criteria for construction of wind farm infrastructure may be based on a number of different factors. The recently published Floating Roads on Peat guidance document (Forestry Civil Engineering (FCE) and Scottish Natural Heritage (SNH), August 2010), provides a list of factors which may influence the decision on whether to excavate or float a road at a particular location; these factors are listed below and may equally apply to design criteria for all main wind farm infrastructure components (not just tracks):

- The type and characteristics of the peat;
- the length of the road section;
- the wind farm road layout;
- the volume of peat requiring to be excavated;
- the location of borrow pits, in particular haul distances, for fill material;
- the Contractor's construction method preference;
- the construction equipment available;
- the number of vehicle movements for each option;
- the footprint of the road on the local habitat;
- restoration requirements;
- peat re-use considerations; and
- CO_2 implications.

It must be highlighted that the majority of these factors can only be considered with any level of assurance at the detailed design stage (post-consent and prior to construction works) when more detailed information is available. The final design of infrastructure in any area of the site will be selected on the basis of the Best Practical Environmental Option (BPEO); this will be ensured through mechanisms such as the SEMP and planning conditions.

At this current stage of evaluation, only the following factors can be reasonably considered in order to estimate preliminary peat excavation and reuse volumes:

- The wind farm layout;
- The type and characteristics of the peat;
- Restoration requirements;
- Peat reuse considerations; and
- CO_2 implications.

Taking into account the “prevent, reduce, reuse, offset” impact mitigation hierarchy noted earlier in this report, the above factors were considered as part of an initial review of peat excavation volumes to determine whether each factor has a significant impact on the overall volumes of peat and whether this should in turn influence the wind farm design and final layout. The result of this is a number of alterations to the wind farm layout and amendments to infrastructure design criteria, which are summarised below. The calculation of estimated excavated and reused peat volumes was then completed and this process is described further in Section 3.0.

2.1 Wind Farm Layout

The wind farm has been reduced in size from 150 to 127 turbines. Impacts on peat were a significant consideration in the revised layout, leading notably to the removal of the entire Collafirth quadrant, predominantly due to deep peat. Further information on the scheme amendments is included within Chapter A.4 (Project Description) of the Addendum ES.

Associated with the reduction in turbine numbers is a significant reduction in track length. It was also identified that the width of access tracks has a significant influence on excavation volumes, as well as track footprint and peat disturbance, resulting in a reduction in proposed double track width from 12m to 10m.

2.2 Type and Characteristics of Peat

Peat depth information (both probed and extrapolated depths) was used to determine the preliminary estimates of excavation volumes for each of the main infrastructure elements. Further detailed information on the type and characteristics of the peat will be available following further ground investigation during the detailed design stages (post-consent) and this will enable refinement of the volume estimates and infrastructure design on a more localised scale.

Reuse of all excavated material within the site is required. Excluding turf layers, excavated peat may be classed as either acrotelmic or catotelmic (further information is provided in SEMP TS3 and TS7). Due to its generally amorphous structure, the reuse options for catotelmic peat are more limited and this material may require treatment to render it suitable for reuse, hence it is necessary to determine the proportion of the total excavation peat volume that is likely to be catotelmic. Erring on the conservative side, and in the absence of detailed peat coring data, for the purposes of this report it has been assumed that all peat below 1m is likely to be catotelmic. This is considered to be a conservative approach (worst case scenario in terms of volume estimates) as the more fibrous acrotelmic layer may actually extend beyond this, and also reuse of pseudo-fibrous catotelmic material is sometimes feasible provided good practice (careful handling and storage procedures) is implemented (refer to TS7).

2.3 Restoration Requirements and Peat Reuse Considerations

The SEMP TS7, Excavated Materials and Reinstatement Plan, provides detail on all restoration, reinstatement and landscaping options that will be utilised to ensure reuse of all excavated materials on site.

Following the review of restoration requirements and peat reuse considerations, it was determined that all excavated peat will be required in reinstatement and restoration. This requirement is based on the assumption that it is preferable to restore some form of ecologically beneficial habitat wherever possible and also to reduce visual impacts, for example through verge reinstatement and landscaping and the reinstatement of double tracks to single width tracks upon completion of construction works. The detailed design of such restoration works will be agreed with the Ecological Clerk of Works and the Geotechnical Consultant / Clerk of Works (as detailed within the SEMP) and is dependant on location suitability (from both an ecological and engineering perspective) and availability of locally excavated peat from infrastructure works.

Restoration of all borrow pits is required. The restoration profile is ultimately dependant on the final excavated profile of the worked pit, however in order to calculate restoration volume requirements some broad assumptions have to be adopted; for this, the updated borrow pit footprint and area figures provided in Chapter A14 of the Addendum ES have been used. The intended restoration methods and material handling requirements (in particular catotelmic material) for borrow pit restoration are detailed within TS7 of the SEMP. For the purposes of volume calculations, it has been assumed that excavated peat will be utilised for restoration of spur tracks out to borrow pits as these are not required post-construction and this will deliver ecological and landscape benefits.

Reinstatement of peat on roadside verges is also considered to be beneficial from both an ecological (improved habitat and reduced run off issues compared to leaving the side slopes bare) and visual impact perspective.

For the purposes of volume estimating, cable trenches are considered to be relatively ‘peat neutral’ as excavated peat is immediately replaced above the cables. Furthermore, due to the shallow depth of cable trenches the excavated peat will be acrotelmic in nature and may be required for burying cables placed at surface level adjacent to floating roads (to avoid excavating cable trenches in virgin material). Therefore, for the purposes of calculating preliminary volume estimates, it has been assumed that no ‘surplus’ or ‘unsuitable’ material will be generated from the excavation of cable trenches and this activity is not considered further.

2.4 CO_2 implications

Minimisation of potential CO_2 emissions from excavation of peat has been considered through the adoption of the assessment hierarchy of avoidance, reduction and reuse. The HMP will also offset impacts by reducing emissions from the wider site area through stabilisation of currently eroding peat and enhancement and restoration of bog in other areas.

The revised wind farm layout has resulted in a reduction of over 100,000m^3 of excavated material compared to the original estimates provided in the 2009 ES.

Through design amendments such as a reduction in the width of proposed access tracks, and also a commitment to continually review the opportunities for further reductions during detailed design and construction phases (to be implemented through the SEMP), significant reductions in excavated volumes will be realised.

This assessment demonstrates that all peat anticipated to be excavated on site will be reused, thus avoiding likely significant carbon impacts associated with off-site disposal and/or treatment. Carbon losses (gaseous, dissolved or particulate) associated with desiccation of excavated materials, run off or changes to the hydrological regime will also be minimised through adoption and implementation of recognised good construction practices for drainage and handling and storage of peat (as detailed within the SEMP).

Where peat may require treatment in order to render it suitable for reuse on site, the treatment option selected will take into consideration the best practical option in terms of minimising carbon losses. If treatment is required, the treatment options will be agreed with SEPA through the Site Working Plan which will be required for the Mobile Plant License (as required for this type of activity).

SECTION 3.0 PEAT VOLUME CALCULATIONS: DESIGN ASSUMPTIONS & ENGINEERING PRINCIPLES

In keeping with the EIA regulations and PAN 58 this report has looked at all possible alternatives and for each of the possible design criteria, the amount of peat proposed to be excavated and reused was initially assessed for a number of different options to highlight how the design criteria impacts on 'the peat calculations'. Where a particular design criteria was demonstrated to have an insignificant impact on the overall volumes (i.e. the resultant approach to managing the materials mass balance on site would not change), one representative input value was selected based on current good practice in wind farm construction.

Further details on each of the main design criteria and associated engineering principles selected for this volume assessment are provided as follows.

3.1 Access Tracks

Access tracks constructed on peat land areas may be either excavated (cut and fill) or of floating construction type. Guidance on track construction in peat land environments is contained within the following documents:

– Constructed tracks in the Scottish Uplands, Scottish Natural Heritage (SNH), March 2005.
– Floating Roads on Peat, Forestry, Civil Engineering (FCE) and SNH, August 2010.
– Good Practice During Windfarm Construction, SNH & SEPA (publication imminent)

Cut & fill track construction involves the excavation of existing peat followed by the placement of hard material gained from the borrow pits into the excavated space. Handling, storage and reuse of excavated peat will be undertaken as per the good practice measures reported in TS7, Excavated Materials and Reinstatement Plan, of the SEMP (Appendix A14.6 of the Addendum ES).

During the initial volume calculations, track design was the one parameter that was found to have a significant impact on overall volumes estimates. Aside from the width of track (which has now been reduced to the minimum required to construct the wind farm safely and efficiently), it is the peat depth at which floating or cut and fill track design is selected that impacts most on the excavated volumes. Although the decision to float a road depends on a number of factors, the FCE/SNH guidance states that floating roads may be on peat depths ranging from 0.6 to greater than 1.5m. Taking this into account, three possible Design Options were defined to demonstrate that the full range of possible outcomes had been considered. This was particularly relevant in terms of potential waste management implications and demonstrating that even the worst case volumes have been considered and are considered to be manageable within the current legislative framework.

For the purposes of this report the overall excavation volumes have been calculated for the following potential Design Options (1, 2 and 3) as follows:

Design 1 Cut and fill between 0.0 – 0.6m (i.e. floating track will be selected where peat depths exceed 0.6m). This represents the potential 'best case' scenario. While the final track design will strive to float as much track as possible, it is recognised that at shallower peat depths other selection criteria will come into play and factors such as engineering practicality and potentially even cost effectiveness of the cut and fill option may outweigh the benefits of floating tracks on such shallow peat. Shallow peat also typically has a very poorly developed, or nil, catotelm, and thus all materials won during excavation of same would be acrotelmic material required for re-use.

Design 2 Cut and fill between 0.0 – 1.0m. This is considered to be the 'middle ground' and is likely to be the most practical and achievable target cut-off depth for floating tracks. Avoiding excavations beyond 1m for tracks as much as possible will reduce the potential for excavation of catotelmic material.

Design 3 — Cut and fill between 0.0 – 1.5m. This represents the potential 'worst case' in terms of volume estimates, however less than 1.5m will always be the 'target' at the detailed design stage in order to minimise excavation volumes.

3.2 Borrow Pit restoration

This report has assumed that all borrow pits will need to be restored and landscaped and the amount of peat required for this purpose has been included in the peat balance calculations. The indicative worked profiles of each borrow pit are illustrated on Figures A14.16a to A14.16m. The actual depth and restoration profile for each borrow pit will be dependant on the final worked profile (which is not possible to determine with any degree of accuracy without detailed ground investigations), however, for the purposes of estimating likely required volumes of material for restoration, as a starting point a target restoration depth of no more than 2m has been selected on the basis that this is a reasonable, achievable and compliant with waste management legislation. The outcome of the mass balance calculations has also determined what the likely depth of restoration would be based on the amount of peat likely to be available for each of the three design scenarios (1, 2 or 3).

3.3 Other Design Assumptions

Other design assumptions selected for the purposes of calculating materials mass balance for tracks are:

i) Total track lengths for development are as follows:

- Single Track 77,360m
- Double Track 27,180m

ii) All single tracks will have a running surface of 6m wide and double tracks will be 10m. Double tracks will be reinstated to single width upon completion of construction works.

iii) Cut and fill tracks will be made up of on average 500mm of imported stone material from the borrow pits.

iv) There will be no peat excavated for the construction of the floating tracks. Floating track construction will be made up of an average of 800mm of stone from the borrow pits.

v) The estimated lengths of cut and floating track for each of the Design Options are provided in the Appendices to this report.

vi) Although in some areas the requirement for one or more drainage channels (either side of a track) is dependent on a number of factors (topography, natural peat pipes, surface flow etc), it has been assumed that a drainage channel will be excavated on one side for cut and fill tracks where the finished road surface is lower than surrounding in-situ peat. The depth of the drainage channel will be 500mm deep and the excavated material to form the channel has been included in the peat volume calculations. All other drainage systems for all other tracks will be determined during the detailed design stage and prior to works commencing on site.

vii) The construction of the operational and borrow pit tracks is assumed to be cut and fill construction for the purposes of the peat volume calculations. The calculations also take into account that the operational and borrow pit tracks may be restored at the end of the construction period.

viii) As reinstated peat will not be mechanically compacted to any significant degree, to allow for settlement an additional depth of 10% will be added to the actual depth of restoration required for all areas excluding verge restoration and landscaping.

ix) Verge restoration and landscaping for all tracks will be calculated on the general principles detailed in Section 2 and in the appendices. The amount of peat required for this has been included in the peat volume calculations.

x) Verge restoration and landscaping for turbine bases, permanent and temporary hardstandings, construction compounds, etc is assumed to be required for those areas that have an existing ground surface gradient 5° or more. The restoration and landscaping of exposed stone verges in these areas is expected to require a minimum depth of 500mm of peat. Surface restoration of these areas will require 600mm of material (with the exception of permanent hardstandings).

xi) Local peat storage areas may be formed adjacent to the turbine bases and permanent hard standing areas. This peat may be used to restore these areas during the decommissioning period. The amount of material required to restore the permanent hardstandings and turbine areas is detailed in Appendix B and has been included in the peat volume calculations.

xii) Restoration of borrow pits is required. For the purposes of calculating preliminary volume estimates for reuse, it has been assumed that restoration with peat will be to a maximum depth of 2m as this is considered to be practical and achievable without posing a risk to the environment or human health (on the assumption that suitable peat is used (either in its natural form or pre-treated)).

xiii) All in-situ peat below 1m is assumed to be catotelmic.

SECTION 4.0 SUMMARY OF PEAT BALANCE CALCULATIONS

Calculations for each area of the development have been presented in Appendices A to D and are summarised in the table below.

For ease of reference, an appendix note is shown next to each estimated volume figure to indicate where the input parameters used to derive the figures can be found. For example A1 – denotes section 1 in Appendix A.
All figures represent cubic metres (m^3).

Peat Excavation or Reuse Requirements	Design 1 Cut and fill track construction on peat depths of 0m – 0.6m. All other tracks to be floating.		**Design 2** **Cut and fill track construction on peat depths of 0m – 1.0m. *** **All other tracks to be floating**		Design 3 Cut and fill track construction on peat depths of 0m – 1.5m. All other tracks to be floating	
Excavation						
Excavated Peat for cut and fill tracks and drainage channels where appropriate	36,664	A1	121,525	A4	305,690	A7
Excavated Peat from turbines	98,704	B1	98,704	B1	98,704	B1
Excavated Peat from permanent and temporary hardstandings	371,379	B2	371,379	B2	371,379	B2
Borrow pit overburden peat	143,537	D1	143,537	D1	143,537	D1
Total Volume Excavated	**650,284**		**735,145**		**919,310**	
[*Estimated portion of total volume excavated that is likely to be catotelmic peat*]	*[215,000]*		*[215,000]*		*[240,000]*	
Reuse						
Verge restoration of cut and fill tracks	1,937	A2	1,937	A5	1,937	A8
Verge restoration of floating tracks and restoration of double to single tracks	186,919	A3	166,331	A6	136,835	A9
Verge restoration for all turbines and hardstandings	42,618	B3	42,618	B3	42,618	B3
Restoration of turbines and temp hardstandings	63,855	B4	63,855	B4	63,855	B4
Restoration of permanent hardstandings	114,300	B5	114,300	B5	114,212	B5
Verge restoration of construction compounds	1,750	C1	1,750	C1	1,750	C1
Restoration of construction compounds	42,000	C2	42,000	C2	42,000	C2
Total Volume Reused	**453,379**		**432,791**		**403,207**	
Peat Balance	**+196,905**		**+302,354**		**+516,103**	
Peat required for restoration of borrow pits (assuming arbitrary max 2m restoration depth)	**354,640**	D2	**354,640**	D2	**354,640**	D2
Approximate depth of borrow pit restoration (using available peat balance).	**1.1m**		**1.7m**		**2.9m**	

Table Notes:

***** *This is considered to be the most realistic scenario that will be achieved on site.*

The above table indicates that without borrow pit restoration there will be a positive peat balance. However, if all of this remaining balance of material is used for the restoration of borrow pits the approximate restoration depth may range between 1.1m and 2.9m and all material excavated will be reused on site.

The suitability of all excavated peat material has been questioned in the past in relation to waste management licensing implications. In order to ensure sufficient material is available for restoration of borrow pits, treatment of potentially ‘unsuitable’ or ‘waste’ material (e.g. catotelmic peat in particular instances), may be required prior to reuse. Treatment may comprise dewatering, blending with more suitable materials, or alternative solution determined by the Contractor. Treatment options will be agreed with SEPA through a “Site Working Plan” which will be required to be prepared by the Contractor if a Mobile Plant License is to be used. An initial review of the feasibility of treatment through blending indicates that for every wet cubic metre of peat (catotelmic peat) excavated there will be an equivalent of 3.4 cubic metres of dry peat (turf and acrotelmic peat) excavated. This ratio of 1:3.4 will allow the wet peat to be mixed with the dry peat which will result in all peat being able to be re-used.

Ultimately, the final depth of borrow pit restoration will be dependant on the final restoration design and will be designed to optimise environmental benefits. As no waste materials will be used (as any potential waste materials will be treated and recovered prior to use) the arbitrary 2m depth limit will not constrain the depth of restoration.

SECTION 5.0 CONCLUSIONS

The 2010 ES Addendum has undertaken a review of all potential avenues for reducing the impacts associated with excavation and disturbance of peat by using the hierarchy below:

- Prevent
- Reduce
- Reuse
- Offset

This review has considered the following factors to estimate preliminary peat excavation and reuse volumes:

- The wind farm layout;
- The type and characteristics of the peat;
- Restoration requirements;
- Peat reuse considerations; and
- CO_2 implications.

The review has resulted in the following design changes to the proposed wind farm which will have a positive effect on the overall impacts on peat land:

- Reduction in turbine numbers
- Reduction in track lengths
- Reduction in double track width from 12m to 10m
- Reinstatement of double tracks to single tracks upon completion of construction

Preliminary estimates of excavation and reuse volumes were calculated once all final design changes were agreed. These estimates are indicative and are based on assumed and necessarily broad design parameters for the entire site; ultimately localised variations in topography and infrastructure design will determine where and how much peat is required for use at a particular point. Every effort has been made to avoid and reduce the excavation of peat so far in the design process. Once detailed ground investigations have been undertaken (post-consent) at the detailed design stage, further opportunities for reducing peat impacts will be considered and potentially achieved.

The assessment of peat impacts is an evolving and iterative process which does not end at the completion of the ES or upon planning consent. The SEMP will provide a mechanism for ensuring that the Contractor continually assesses peat impacts (through avoidance, reduction and careful reuse of excavated peat) throughout the construction phase. The good practice measures specified within the SEMP are also in line with all current legislation and guidance relating to pollution prevention, habitats and species protection and waste management.

For the purposes of calculating preliminary volume estimates, the calculations for turbine bases, permanent and temporary hardstandings, construction compounds and borrow pits are based on the conservative assumption that all peat will require excavation and the input parameters are fixed. It is recognised that during detailed design stages of the development more detailed ground investigation will enable design changes, which may result in a decrease in peat excavation (for example micrositing to shallower peat areas and even potential piled solutions will require further investigation and may be adopted where engineering and other environmental constraints allow).

The amount of peat excavated and reused for tracks will vary depending on the design of the track construction (i.e. width of track and floating versus cut and fill construction methods). In order to explore potential ranges in excavated peat volumes that may arise during site works, three design options for tracks have been explored based on the maximum depth at which cut and fill tracks would be used:

Design 1 0.0-0.6m
Design 2 0.0-1.0m
Design 3 0.0-1.5m

The table below summarises the overall peat balance calculations for the whole development including different track designs. The estimated volumes of catotelmic peat are based on the assumption that all peat below 1m is catotelmic.

	Design 1 Construction of Wind Farm with cut and fill tracks constructed on peat depths 0m – 0.5m. All other tracks to be floating.	**Design 2** Construction of Wind Farm with cut and fill tracks constructed on peat depths 0m –1.0m. All other tracks to be floating.	**Design 3** Construction of Wind Farm with cut and fill tracks constructed on peat depths 0m – 1.5m. All other tracks to be floating.
Total Volume Excavated **[*Estimated portion of total volume that is likely to be catotelmic peat*]**	650,200 *[215,000]*	**735,100** ***[215,000]***	919,300 *[240,000]*
Total Volume Reused (not including borrow pit restoration)	453,700	**433,100**	403,300
Peat Balance (prior to borrow pit restoration) (+ indicates positive balance)	+ 196,500m³	**+ 302,000 m³**	+ 516,000
Amount of peat required for restoration of borrow pits up to a maximum depth of 2m	354,600 m³	**354,600 m³**	354,600 m³
Estimated depth of borrow pit restoration using available volume	1.1 m	**1.7 m**	2.9m

Given that the preliminary volumes estimates are necessarily based on some very broad assumptions, the numbers provided in the above table have been rounded to avoid "false precision" in reporting of the actual figures generated from the calculations.

Although available guidance documents indicate that floating roads may be constructed on peat depths ranging between 0.6 and 1.5m, and it is possible that peat volumes may range anywhere between Design 1 and 3, it is considered that the target depth of 1.0m (as defined by Design 2) is the most representative scenario that will be reasonably achieved during construction works at this site.

Taking out volumes required for restoration of other infrastructure, it has been calculated that the volume of material available for restoration of borrow pits would result in approximate borrow pit restoration depths ranging between 1.1 and 2.9m, and the Design 2 depth of 1.7m (or less) is considered to be most likely.

In order to be able to reuse all excavated materials, treatment of potentially ‘unsuitable’ material, e.g. catotelmic peat, may be required prior to reuse. Treatment options will be agreed with SEPA through a “Site Working Plan” which is a specific requirement for operating under a Mobile Plant License (likely to be required for this type of activity. Treatment through techniques such as dewatering or blending with other materials is considered to be viable and therefore it is considered that all peat excavated will be able to be re-used on site.

Ultimately, the final depth of borrow pit restoration will be dependant on the final restoration design and will be designed to optimise environmental benefits. As no waste materials will be used (as any potential waste materials will be treated and recovered prior to use) the arbitrary 2m depth limit will not constrain the depth of restoration.

Whilst a range of potential outcomes (i.e. three possible design options) have been assessed, the EIA regulations states that the assessment should report the effects that are considered to be likely, informed by the assessor’s own expertise and critical review of available guidance. It is these likely effects that the applicant is obliged to report, and that Scottish Ministers are obliged to consider (Regulation 3(1), 4(1). In this case, the outcomes of the Design 2 assessment are considered to be the most likely and there will not be a significant surplus of material that cannot be legitimately reused on site in compliance with current legislation.

Appendix A Track Construction Peat Calculations Peat Depth 0m – 0.6m

A1 Cut and Fill tracks on Peat Depths between **0m and 0.6m**. (Single track 6m wide, double track 10m wide)

Total length single track of cut and fill		10,237m
Total length of operational and borrow pit tracks	799 + 1366=	2,165m
Width of single track		6m
10% additional double track		1023m
Width of double track		10m
Average depth of peat		0.320m
Average Depth of peat for operational and borrow pit tracks		1m
Allowance for drainage channel on one side		$0.15m^3$
Length of drainage channel for tracks in peat depths greater than 0.5m	2,165 + 2800=	4965m

Total amount of projected excavated peat

(10,237 x 6 x 0.320) + (1,023 x 10 x 0.320) + (2,165 x 6 x 1) + (4,965 x 0.15) = $36{,}664m^3$

A2 The majority of the finished track surface will on average be 0.214m above existing ground level. Verges will require support and landscaping using excavated peat

Total length of track	8460m
No of Verges	2 No
Depth of restoration	0.214m
Horizontal length of restoration (5 x Depth)	1.07m

Amount of peat for verge support

(8,460 x 2 x 0.214/2 x 1.07) = $1{,}937\ m^3$

A3 Floating track construction above peat depth of **0.6m**

Total length of single track	77,360 – 12,402 = 64,958m
Total length of double track	27,180 – 1,023 = 26,157m
Total Floating road distance	91,115m

Floating track will be 0.5m above existing ground level. Verges will require restoration and landscaping using excavated peat

Total length of track	91,115m
No. of verges	2 No
Depth of restoration	0.5m
Horiz length of restoration (5 x Depth)	2.5m

Amount of peat for verge restoration and landscaping

91,115 x 2 x 0.5/2 x 2.5 = $113{,}893m^3$

Amount of peat req'd to restore double tracks to tracks of 6m width and restore operational and borrow pit tracks

Total length of double track	27,180m
Width of restoration	4m
Total Length of operational and borrow pit tracks	2165m
Width of operational and borrow pit tracks	6m
Depth of restoration	0.6m

Total amount of peat required for restoration of double tracks to single tracks

(27,180 x 4 x 0.6) + (2,165 x 6 x 0.6) = $73{,}026m^3$

A4 Cut and Fill tracks on peat depths between 0m and 1.0m.

Total length of cut and fill single track		25,210m
Total length of operational and borrow pit tracks	799 + 1366 =	2,165
Width of single track		6m
10% additional double track		2521m
Width of double track		10m
Average depth of peat for tracks		0.598m
Average depth of peat for operational and borrow pit tracks		1m
Allowance for drainage channel on one side		0.15m³
Length of drainage channel for tracks in peat depths greater than 0.6m	27,731 – 7691 =	20,040m

Total amount of projected excavated peat

(25,210 x 6 x 0.598) + (2,165 x 6 x 1) + (2,521 x10 x 0.598) + (0.15 x 20,040) = 121,525m³

A5 Peat required for restoration and landscaping of cut and fill track verges

Total length of track above 500mm	8460m
No of verges	2 No
Average Depth of support	0.214m
Horizontal length of support (5 x vertical depth)	1.07m

Amount of Peat for verge support

8460 x 2 x 0.214/2 x 1.07 = 1,937m³

A6 Floating track construction above peat depth of **1.0m**

Total length of single track	77,360 – 27,375	= 49,985m
Total length of double track	27,180 – 2,521	= 24,659m
Total Floating road distance		74,644m

Floating track will be 0.5m above existing ground level. Verges will require restoration and landscaping using excavated peat

Total length of track	74,644m
No of verges	2 No
Depth of restoration	0.5m
Horiz length of restoration (5 x Depth)	2.5m

Amount of peat for verge support

(74,644 x 2 x 0.5/2 x 2.5) = 93,305m³

Amount of peat required to restore double track to single track and restoration of operational and borrow pit tracks

Total length of double track	27,180m
Width of restoration	4m
Depth of restoration	600mm
Total length of operational and borrow pit tracks	2,165m
Width of restoration	6m
Depth of restoration	600mm

Amount of peat for restoration

(27,180m x 4 x 0.6) + (2,165 x 6 x 0.6) = 73,026m³

A7 Cut and Fill tracks on peat depths between 0m and 1.5m.

Total length of cut and fill single track		46,922m
Total length of operational and borrow pit tracks	799 + 1366 =	2,165
Width of single track		6m
10% additional double track		4,692m
Width of double track		10m
Average depth of peat for tracks		0.882m
Average depth of peat for operational and borrow pit tracks		1m
Allowance for drainage channel on one side		0.15m³
Length of drainage channel for tracks in peat depths greater than 0.6m	27,731 – 7691 =	20,040m

Total amount of projected excavated peat

(46,922 x 6 x 0.882) + (2,165 x 6 x 1) + (4,692 x10 x 0.882) + (0.15 x 20,040) = 305,690m³

A8 Peat required for restoration and landscaping of cut and fill track verges

Total length of track above 500mm	8460m
No of verges	2 No
Average Depth of support	0.214m
Horizontal length of support (5 x vertical depth)	1.07m

Amount of Peat for verge support

8460 x 2 x 0.214/2 x 1.07 = **1,937m³**

A9 Floating track construction above peat depth of **1.0m**

Total length of single track	77,360 – 49,087	= 28,273m
Total length of double track	27,180 – 4,692	= 22,488m
Total Floating road distance		50,761m

Floating track will be 0.5m above existing ground level. Verges will require restoration and landscaping using excavated peat

Total length of track	50,761m
No of verges	2 No
Depth of restoration	0.5m
Horiz length of restoration (5 x Depth)	2.5m

Amount of peat for verge support

(50,761 x 2 x 0.5/2 x 2.5) = 63,451m³

Amount of peat required to restore double track to single track and restoration of operational and borrow pit tracks

Total length of double track	27,180m
Width of restoration	4m
Depth of restoration	600mm
Total length of operational and borrow pit tracks	2,165m
Width of restoration	6m
Depth of restoration	600mm

Amount of peat for restoration

(27,180m x 4 x 0.6) + (2,165 x 6 x 0.6) = 73,026m³

Appendix B Turbine Base, Permanent and Temp Hardstanding Peat Extraction and Re-use

Each turbine has the following dimensions
Turbine Base 484m²
Permanent Hardstanding 1500m²
Temporary Hardstanding 354m²

Based on peat depths the following table shows quantities of material generated or required.

Turbine No	Depth of peat (m)	Excavated peat from base (m^3)	Excavated peat from hardstandings (m^3)	Peat required for verge protection and support of turbine basis and perm hardstanding only
D16	2	968	3708	316
D12	1.6	775	2966	316
D11	3	1452	5562	510
D13	1.6	775	2966	316
D9	1.1	533	2040	0
D7	2.5	1210	4635	510
D18	1	484	1854	575
D25	1.9	920	3523	510
D17	1.6	775	2966	255
D24	1.9	920	3523	639
D28	0.6	290	1113	0
D23	2	968	3708	381
D27	2	968	3708	316
D26	0.7	339	1298	255
D29	0.7	339	1298	316
D6	1.8	872	3338	381
D30	3.1	1500	5747	575
D31	0.8	388	1483	700
D32	0.2	968	370	316
D33	0.8	388	1493	255
N125	0.8	388	1483	316
D14	1.7	823	3152	128
N128	1.1	533	2040	381
N127	0.9	436	1669	0
N126	1	484	1854	316
N96	2.3	1113	4264	700
N92	1.7	823	3152	255
N94	1.6	775	2966	190
N97	1.3	630	2410	127
N91	1.2	580	2225	445
N99	1.5	726	2781	255
N90	2	968	3708	316
N104	1.4	678	2596	316
N123	1.9	920	3523	381
N98	1.1	533	2040	972
N103	2	968	3708	381
K78	0.6	290	1113	190
N105	1.5	726	2781	127
N89	2.2	1065	4079	445
N102	1.5	726	2781	317
N100	2.4	1162	4450	0
K79	2	968	3708	190
N95	1.1	533	2040	381
N101	2.1	1016	3894	0

Turbine No	Depth of peat (m)	Excavated peat from base (m³)	Excavated peat from hardstandings (m³)	Peat required for verge protection and support of turbine basis and perm hardstanding only
N106	2.4	1162	4450	255
K80	2.1	1010	3894	0
N93	2.5	1210	4635	127
K42	2.1	1016	3894	700
N107	1.8	872	3338	0
K81	2.3	1113	4264	0
N108	1.6	775	2966	317
D5	3.9	1888	7230	510
K43	1.2	580	2225	0
N122	1.7	823	3152	381
N109	2.1	1016	3894	190
K82	1.1	533	2040	317
K49	0.9	436	1669	639
K46	0.3	146	556	445
K44	1.6	775	2966	575
N139	1.7	823	3152	381
N138	1.9	920	3523	381
K83	2.7	1307	5005	381
K45	0.8	388	1483	255
K47	1.1	533	2040	190
K51	2.5	1210	4635	639
N141	1.1	533	2040	317
N149	3.2	1549	5932	127
K84	1.6	775	2966	127
N142	2	968	3708	255
N148	1.2	580	2225	445
K50	2.5	1210	4635	317
K48	2	968	3708	510
N143	1.5	726	2781	317
N129	1	484	1854	768
N124	1.5	726	2781	768
N119	0.5	242	927	255
N120	1.5	726	2781	381
N147	2	968	3708	317
K85	2.3	1113	4264	0
N144	1.4	678	2596	190
N140	1.5	726	2781	510
K53	2.5	1210	4635	574
K52	0.6	290	1113	510
N118	1.4	678	2596	255
K55	1.3	630	2410	639
K86	2.1	1016	3894	0
N145	0.2	968	371	317
K54	1.7	823	3152	510
K57	1.5	726	2781	317
N116	1.5	726	2781	510
N150	1.5	726	2781	190

Turbine No	Depth of peat (m)	Excavated peat from base (m^3)	Excavated peat from hardstandings (m^3)	Peat required for verge protection and support of turbine basis and perm hardstanding only
N131	1.4	678	2596	510
N117	1	484	1854	255
K87	1.5	726	2781	127
K56	1.2	580	2225	0
K58	1.3	630	2410	0
K71	0.9	436	1669	510
N132	0.5	242	927	317
K59	1.5	726	2781	33
N113	2.1	1016	3894	445
N110	2	968	3708	0
N114	1.5	726	2781	574
K88	0.8	388	1483	445
K68	1.3	630	2410	127
K70	1.4	678	2596	445
N111	1.6	775	2966	317
K60	1.2	580	2225	510
N137	1.7	823	3152	381
K72	2.6	1258	4820	510
N115	1.7	823	3152	255
K69	1.5	726	2781	127
N112	0.8	388	1483	255
K61	1.3	630	2410	639
K62	1.8	872	3338	574
K67	0.5	242	927	510
K63	1.9	920	3523	381
K66	1.2	580	2225	639
K73	2	968	3708	317
K64	1.8	872	3338	510
K75	2.2	1065	4079	445
K74	2.9	1404	5376	127
K77	2.3	1113	4264	381
K76	1.8	872	3338	381
D15	1.7	823	3152	381
D10	2.2	1065	4079	510
Total		**98,704**	**371,379**	**42,618**
		B1	**B2**	**B3**

B4 Peat required to restore turbine bases and temp hardstandings

No. of bases	127No
No. of temp hardstanding	127No
Area of each base	$484m^2$
Area of temp hardstanding	$354m^2$
Depth of restoration	600mm

Total volume of peat required for restoration

(127 x 484 x 0.6) + (127 x 354 x 0.6) = **63,855m^3**

B5 Peat stored for restoration of permanent hardstandings

No. of perm hardstandings	127No
Area of perm hardstandings	$1500m^2$
Depth of restoration	600mm

Total volume of peat required for restoration

(127 x 1,500 x 0.6) = **114,300m^3**

Appendix C Construction Compounds Peat re-use

C1 All construction compounds to be floating type construction.

Peat required for verge support

No of construction compounds	7 No
Length of verge	400m
Depth of support	600mm
Horizontal Depth of Verge	2.5m

Peat required for verge support

(7 x 400 x 0.5/2 x 2.5) = **1,750m³**

C2 Peat required for restoration of construction compounds

No of construction compounds	7 No
Area of compound	10,000m²
Depth of restoration	600mm

Peat required for restoration of construction compounds

(7 x 10,000 x 0.6) = **42,000m³**

Appendix D Borrow Pit Peat Extraction

D1

Borrow Pit No	Area of Pit (m^2)	Depth of Overburden Peat (m)	Volume of Overburden Peat Excavated (m^3)
DBP 01	2,980	0.8	2,384
DBP 02	17,190	0.6	10,314
DBP 03	12,130	0.5	6,065
KBP 01	12,350	0.8	14,732
KBP 02	14,140	0.8	23,098
KBP 03	14,700	0.9	13,230
KBP 04	13,410	0.3	4,023
KBP 05	5730	0.9	5,157
NBP 01	25,360	1.1	27,896
NBP 03	7,750	0.8	6,200
NBP 04	8,420	0.8	6,736
NBP 05	21,700	0.4	8,680
NBP 06	21,460	0.7	15,022
Total	177,320		143,537

After the stone has been extracted from the borrow pits, the borrow pits will then be backfilled and restored up to a maximum depth of 2m.

D2 Amount of peat required to restore and landscape borrow pits

Area of Borrow Pits 177,320m^2
Depth of Restoration 2m

(177,320 x 2) = **354,640m^3**