4. DEVELOPMENT DESCRIPTION

4.1 INTRODUCTION

This Chapter describes the elements that constitute the Viking Wind Farm proposal. The aim is to provide an appropriate level of detail to provide a basis for Environmental Impact Assessment. It should be noted that some of the design and technical details will only be finalised upon award of design and build construction contracts, and will vary according to the specific turbine model and contractors selected. Consequently the description is generic and provides for the anticipated maximum physical characteristics, various options, and typical arrangements as appropriate.

Viking Energy Partnership is committed to taking every opportunity which is commercially viable to improve, not just maintain, the environment as affected by the Viking Wind Farm. To this end the Partnership is committed to adopting all current accepted best practice in the design, construction and operational methods used on site.

The development description considers:

- The core wind farm components, including turbines and tracks;
- control buildings and substations;
- associated development including DC convertor station (subject to a separate planning application), borrow pits, access from and modifications to public roads;
- wind farm construction details, including outline programme and details of temporary construction facilities;
- operational activities;
- the wind farm decommissioning process;
- general mitigation measures; and
- an explanation of how the design has evolved to take into account issues and recommendations identified during the Environmental Impact Assessment.

Figures 4.1.1 and 4.1.2 illustrate the proposed wind farm layout, and a list of turbine and anemometry mast co-ordinates is provided at Appendix 4.2. In practice, more detailed topographical and geotechnical surveys would precede the start of construction works and turbine positions and track routes may be amended by up to 50 metres with the approval of (or at the request of) on-site archaeologists, ecologists, and any other relevant specialists supervising construction activities, or by up to 100 metres with the approval of appropriate local consultees, for example Shetland Islands Council, SNH or SEPA.

4.2 CORE DEVELOPMENT COMPONENTS

4.2.1 Turbines

It is proposed to install 150 wind turbines.

A number of wind turbine manufacturers produce models which would be appropriate for the Viking site, and the specific turbine model would be selected following a procurement exercise. The following description is generic but allows for all such turbines.

Above ground, each turbine would comprise:

- A tubular tower, up to 90 m high, with door and internal access systems;
- a nacelle at the top of the tower housing generator, gearbox, hydraulic and electric control systems, and externally mounted anemometry instruments;
- a rotor mounted on the nacelle comprising a central hub and three blades, with an overall diameter of approximately 110 m;
- a transformer to step up voltage from 690V to 33,000V, at ground level within an external housing, or contained within the base of the tower, or contained within the nacelle, depending on the make of turbine.

Figure 4.2 illustrates a typical wind turbine elevation with the maximum proposed overall tip height of 145m (comprising 90m tower and 55m blade length).

Suitable wind turbines have a capacity of 3 MW to 3.6 MW, giving an overall electrical capacity of up to 540MW.

It is proposed that in this case the colour of the turbines would be matt pale grey which would serve to attenuate the visibility of turbines from medium to long distance viewpoints, since they would typically be seen against the skyline. It is proposed that any external transformer cubicles would be coloured matt dark brown to attenuate visibility against open moorland. However, the final colour schemes would be agreed with the planning authority.

This type of turbine typically generates electricity between wind speeds of 3 to 25 m/s, with maximum output typically above 12-14 m/s. The rotor would be upwind of the tower, and all rotors would rotate in the same direction. The speed of rotation would vary from approximately 5 to 13 rpm according to wind speed. The operation of the turbine would be controlled by yawing the nacelle so that the rotor faces the current wind direction, and by feathering blades. Above maximum permissible wind speeds the turbine would be shut down. A brake can be applied to the rotor during maintenance.

The turbine components will be delivered as the following loads:

- Up to three tower sections, delivered individually;
- the foundation section;
- the nacelle, possibly with the drive train as a separate load;
- the hub;
- the transformer and its housing; and
- three blades, delivered individually or in pairs.

The components would be unloaded by one or more heavy lift cranes, and constructed in a modular fashion. The rotor may be assembled at ground level and lifted as a single unit, or assembled at hub height as single blade lifts. Assembly, in general, requires only fixing of bolts, torquing of nuts and electrical and hydraulic connections. Depending on weather conditions, a turbine can be erected in one to two days.

4.2.2 Turbine foundations

Each turbine would have a reinforced concrete foundation, typically of dimensions 22 m square by 1-2 m thick. Bolts or a short tower section would be cast into the foundation, and would form the connection to the basal tower section (Figure 4.3).

The foundation will be formed as follows:

- Overburden will be excavated down to formation level, as determined by geotechnical studies. The excavation typically would be 3 m to 4 m deep by approximately 25 m square.
- A temporary drainage system will be established according to the local gradient – either a pump or a temporary ditch (see chapter 14 for details of how drainage issues will be addressed).
- The required level will be made up with compacted crushed rock placed in the base of the excavation.
- A layer of blinding concrete will be laid.
- A reinforcing steel 'cage' will be assembled.
- Shuttering will be assembled.
- Concrete (nominally 700m^3 per foundation) will be poured continuously.
- Once the concrete is set, the shuttering will be removed, and an electrical earthing mat and rock or spoil will be placed over the concrete pad.
- Where the foundation is based upon a drained design, a permanent drainage system, typically comprising buried perforated pipes or French drains, will be installed around the foundation. Alternatively it will be undrained.
- Following erection of the turbine, suitable overburden and turves will used to landscape and reinstate the foundation.

4.2.3 Tracks

Tracks are required to enable the turbine components and construction materials to be transported to their locations, and to enable ongoing access for subsequent maintenance visits. There are main 'access' tracks to the wind farm site, and there will be a series of 'site' tracks accessing each turbine and the borrow pits, anemometers, control rooms and substations (Figure 4.1). There will be three standards of track, all of which will remain in place for the lifetime of the wind farm:

- Single width construction tracks, with a running surface approximately 6 m wide
- Double width construction tracks along main arterial routes with a running surface approximately 12m wide, to minimise congestion.

- Operational tracks, built to a lower specification, and with a 3.5 m running surface, to provide short cuts for lighter operational vehicles.

Some access tracks follow the routes of existing hill tracks. These will be utilised as far as is practical, following appropriate upgrading to a standard required for wind turbine construction and maintenance access.

Appendix 4.1 provides further information on the design process for the track layout, and in particular how it has sought to maintain or restore a natural pattern of peatland hydrology.

(a) **Track construction**

The type of track construction will vary according to the ground conditions.

'Type A' construction will be used on hard ground, typically less than 1 - 1.5 m of peat, and on steeper gradients. This construction is often referred to as 'cut'. On softer areas, typically more than 1.5 m of peat, 'Type B' construction will be used. This construction is often referred to as 'floated', although in practice there will be a degree of subsidence. Figure 4.4 illustrates Type A and Type B track constructions, which are similar to forestry-type tracks. Generally it is preferable for engineering reasons to maintain uniform track construction types unless there is a significant length of ground which requires the construction type to be changed. Therefore the track type would remain as 'Type A' across short lengths of deep peat (say up to about 50 - 75m); and vice versa. Variations in ground conditions of more than 50 - 75m would justify a change in the construction method; and of course gross changes in the ground conditions will be dealt with on a case-by-case basis.

The approximate lengths of the tracks constructed by cut and float methods are given in Table 4.1:

Table 4.1 Cut and float track lengths

Track Method	Collafirth		Delting		Kergord		Nesting		Overall Site		
	Cut (km)	Float (km)	Cut (km)	Float (km)	Cut (km)	Float (km)	Cut (km)	Float (km)	**Cut (km)**	**Float (km)**	**TOTAL (km)**
Single Width	0.51	5.57	4.34	17.00	9.85	18.71	2.83	24.85	**17.53**	**66.14**	**83.67**
Double Width			3.62	4.07	1.62	5.30	4.70	9.11	**9.93**	**18.47**	**28.40**
Operational					2.04	0.62		0.78	**2.04**	**1.40**	**3.44**
Borrow Pit Access and Operational			1.36				0.66		**2.02**		**2.02**
TOTAL	**0.51**	**5.57**	**9.32**	**21.07**	**13.51**	**24.63**	**8.18**	**34.74**	**31.51**	**86.01**	**117.52**

It is proposed that a method statement for the construction of the tracks be agreed prior to construction, using current best practice. The aims of such a method statement would be to ensure a suitable quality of track, safe and efficient working, prevention of pollution, and the meeting of hydrological, ecological, archaeological and landscaping objectives. The following paragraphs describe the likely basic principles.

Formation of a Type A track involves:

- Removal and temporary storage of turves, as appropriate
- Excavation down to formation level
- Formation of side drains to suit
- Emplacement and compaction of stone to a depth of 400 to 600 mm
- Emplacement and compaction of fines on the surface
- Reinstatement of the verges with original turfs

Formation of a Type B track involves:

- Removal and temporary storage of turves, as appropriate
- Laying a geotextile membrane
- Removal and temporary storage of adjacent turves
- Emplacement and compaction of stone to a depth of 600 to 800 mm
- Emplacement and compaction of fines on the surface
- Reinstatement of the batters with peat and original turves.

The running width of the tracks will be 6 - 12 m with a total footprint of tracks, including any ditches and batters, of approximately 10 - 16m. The tracks will be appropriately widened at corners and junctions and provided with passing places. The estimated total length of Type A track is 32km, and the estimated total length of Type B track is 86km, giving a total approximate length of 118km. These lengths are subject to changes caused by micrositing during construction to account for environmental and engineering requirements. See section 4.1 for further details of micrositing arrangements.

(b) **Stream crossings**

The track layout has attempted to minimise the number of stream crossings as far as practical whilst taking account of other constraints. Appendix 4.2 outlines water crossing guidelines, which will be subject to agreement from SEPA and licensing under the *Water Environment* (*Controlled Activities) (Scotland) Regulations 2005*, where necessary.

4.2.4 Control buildings and sub-stations

The wind farm will be clustered into three main electrical sub-groups, each connected to a local sub-station. The Delting quadrant will be connected to a sub-station at Wester Scord, about 3.5km east-south-east of Brae; the southern Nesting quadrant will be connected to a sub-station at Moo Field, about 3km north of Catfirth; and the balance will be connected to a larger substation (consisting of three individual sets) adjacent to the AC/DC convertor station (see Figure 4.1.2 and Section 4.3.1 below).

The purpose of the sub-stations is to transform the voltage from 33kV to 132kV. The substations will comprise transformers, circuit breakers and isolators. The electrical plant may be housed within a building, or alternatively it may be contained within an external compound. The compound will be within a 2.74 m high galvanised security fence (Figure 4.5, Figure 4.8).

Adjacent to each sub-station will be a control building, which serves as a collection point for electrical circuits from wind turbines, and houses switchgear and control equipment. There may be a requirement for an external compound housing voltage control equipment. The building will also provide storage for tools and spares, and welfare and amenity facilities for operational staff.

The main control building will be located in the Kergord valley, and will be a larger building with workshop space (Figure 4.1.2, Figure 4.5, Figure 4.6). It is envisaged that the Delting substation at Wester Scord will be connected to the convertor station by means of a wooden pole mounted 132 kV trident line, on a route to be determined by Scottish Hydro Electric Transmission Limited (SHETL), and that the South Nesting Sub-station at Moo Field will be connected to the convertor station by means of an underground 132 kV cable[1].

4.2.5 On-site cabling

The turbines will be electrically connected to the control building by means of sets of three 33 kV cables. The cables, along with control and telecoms cables, and earthing tape, will be laid underground in trenches. The trenches will be backfilled, possibly partially with sand brought onto the site. Alternatively, cables may be laid by means of a cable plough. In both cases, cables would be marked with buried safety warning tape, and reinstated. The estimated total length of cable run is 118km. The advice of Viking Energy's peatland hydrologist is that the design principles relevant to the track layout will also apply to the cables. Therefore cables will generally be laid adjacent to the site tracks.

4.2.6 Anemometers

(a) Permanent masts

11 permanent anemometry masts would be required for control purposes and to ensure the efficient operation of the windfarm. The proposed mast locations are marked on Figures 4.1.1 and 4.1.2. The masts would be free standing lattice construction up to 90 m high (Figure 4.7).

(b) Temporary masts

Temporary masts will be required at the site of, and in front of, selected turbine bases in order to perform subsequent performance and acceptance tests on the turbines. The

[1] Since the route of the overhead line is still to be determined it does not fall within the scope of the current EIA. The line would require consent under section 37 of the *Electricity Act* 1989.

locations would be agreed with the turbine supplier. These masts will probably be of guyed type construction. At each selected turbine site, one mast would be removed prior to erection of the turbine, and the other mast would remain for up to a year after commissioning.

4.3 ASSOCIATED DEVELOPMENTS

4.3.1 DC convertor station

The Viking Wind Farm will be connected to the GB transmission system by means of a sub-sea HVDC[1] link (which does not form part of the wind farm application for Section 36 consent). National Grid Electricity Transmission Ltd (NGET) is responsible for managing access to the GB transmission system, and SHETL is responsible for planning the link and making it available. Viking Energy, NGET and SHETL have held discussions to identify practical and optimal designs. SHETL consulted on its preliminary proposals in March 2008 which are summarised below.

The HVDC link will comprise up to three modules, each with a pair of sub-sea/terrestrial cables and AC/DC conversion equipment at convertor stations on Shetland and mainland Scotland. SHETL is proposing that the Shetland convertor station is located in the Kergord valley, and that the DC cables make the land/sea transition at Weisdale Voe (Figure 4.1). Submarine cables would be laid over a route length of some 330 km to a landing point near Portgordon, Buckie, on the Moray coast, and then continued underground to a convertor station at Blackhillock, near Keith. Here the DC link would connect with the existing north of Scotland transmission network. Connection at Blackhillock relies on completion of various upgrades to the north of Scotland transmission system that are already required to accommodate other proposed generation projects as identified in SHETL's March 2008 consultation.

The Kergord (and Blackhillock) convertor station would comprise up to three convertor modules. Each module would include a steel clad building approximately 120 m long, by 30 m wide, by 17 m high containing electrical filters, reactors, valves and associated equipment; and switchgear, transformers and cooling fans within an external compound. Adjacent to the convertor station would be the main wind farm 33/132 kV sub-station (Section 4.2.4). The compound containing the convertor modules and main sub-station would be approximately 200 m by 250 m (Figure 4.8).

4.3.2 Borrow pits

An estimate of up to approximately 1.5 million m^3 of stone would be required for various purposes, primarily for track construction. Whilst some of this could be obtained from foundation excavation, much of it would be sourced from on site borrow pits, minimising the need to import stone on the public roads system. Proposed borrow pit locations, some of which are on the sites of former borrow pits, have been selected taking into account the following criteria:

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[1] High voltage direct current

- Potential suitability of rock type;
- estimated adequacy of quantity;
- accessibility;
- appropriateness of land form to provide a working face;
- depth of overburden to avoid unnecessary excavation of material; and
- potential environmental impacts.

Potential sites were identified following site investigations by Mouchel (Appendix 4.3). Proposed borrow pit sites are identified on Figure 4.1.

Allowing for 10% 'wastage' in the form of unusable overburden or unsuitable rock, it is estimated that the total void required is approximately 1,000,000 m^3. It is likely that more than one borrow pit would be opened up in each quadrant, to minimise the haul distance and physical extent of any one location. The form of the borrow pits would be subject to detailed assessment, but they are designed to be free-draining in order to avoid the formation of potentially hazardous voids. Further information about the borrow pits is presented in Appendix 14.2.

It is proposed that a method statement for the formation, management and restoration of the borrow pits be agreed prior to opening up the borrow pits, using current best practice. The aims of such a method statement would be to ensure efficient safe working, prevention of pollution, and the meeting of hydrological, ecological, archaeological, noise and landscape objectives. The following paragraphs describe the likely basic principles, which would be modified accordingly in the case of reopening of former borrow pit sites:

- A series of trial pits and test drills would be made to inform the design.
- Pollution prevention measures such as silt traps would be established to protect any vulnerable watercourses.
- Turves would be removed and temporarily stored.
- Overburden would be removed and stored.
- A working face would be established.
- The borrow pit would be worked either by excavator, or by combination of excavator and drill and blast, depending upon the characteristics of the rock. Typically, blasting would occur a maximum of once per week.
- If necessary the rock would be graded and crushed in a mobile crusher plant.
- Upon completion, the borrow pit would be partially reinstated, involving reworking of faces to stabilise them, partial infilling with surplus material, and landscaping.

4.3.3 Modifications to public roads

It is proposed that the site will be accessed via new junctions at locations illustrated on Figures 4.1.1 and 4.1.2. The detail of junction design would be agreed with SIC Roads Service, but is likely to include formation of a bell mouth to accommodate abnormal loads, opening up sight lines where necessary, and laying tarmac at the junction and for an appropriate length along the access track.

There are two options for delivery of turbine components, either or both of which may be used:

- From Gremista; or
- from Sullom Voe/Sella Ness.

An abnormal load transportation study has been undertaken and is included at Appendix 15.2. The study concluded that the Sullom Voe/Sella Ness option would require the shortest total kilometres of travel for abnormal loads between the port of entry and the wind farm access tracks, and for this reason, and others, this option is currently favoured by the Viking Energy Partnership. Very few modifications to the public roads are likely to be required because of the generally high standard of Shetland roads. Modifications which are likely to be required are as follows:

- Sella Ness access junction to allow long loads to exit;
- site access at Houb of Scatsta, on the B9076 about 1km south of Sella Ness, to allow long loads to turn left (south) into the site;
- B9076 / A968 junction near Mossbank to allow long loads to turn right (south);
- A968 access to the Collafirth quadrant near the Hill of Susetter, to allow long loads to turn left (east) and then right (south) into the site;
- A968 / A970 junction at Voe, to allow long loads to negotiate the junction;
- A970 access to North Nesting and Kergord at Hamarigrind Scord (this will be a staggered junction with the access to Kergord slightly north of the access to North Nesting);
- A970 / B9075 (Weisdale arm), involving junction improvements and carriageway upgrading, and creation of a new access junction at the unclassified turn-off to Upper Kergord;
- A970 access to South Nesting east of Sand Water.

The Traffic Assessment (Appendix 15.1) outlines the different transportation options considered and explains why the above are the preferred options.

4.4 CONSTRUCTION DETAILS

4.4.1 Construction activities and programme

The construction period for the development would be approximately 5 years on-site. The timing of commissioning of the HVDC link is critical, since the turbines cannot be commissioned without it.

Construction would comprise the following main activities:

- Site establishment and installation of site offices

- Civil works, including the formation of borrow pits, tracks and foundations, and concluding reinstatement works
- Turbine delivery, erection and commissioning
- Electrical works, including cabling and construction of substations

Table 4.2 illustrates an indicative construction programme for the project.

Table 4.2 Indicative construction programme

Shaded cells indicate activity taking place:

Year	**1**	**2**	**3**	**4**	**5**
Civil works					
Turbine installation					
Site electrical works					
HVDC link					
Reinstatement					
Completion					X

4.4.2 Construction workforce

It is estimated that the on-site construction workforce would total around 200 individuals on average, comprising civil engineering contractors, turbine contractors, electrical contractors and project management staff. Manning levels would vary according to the construction phase, the highest requirements occurring as the civil works near completion and the first turbines are installed. At this point the workforce might reach approximately 400 individuals. Non-local construction personnel will be accommodated off the site, typically in locally provided accommodation. One option for accommodation of the construction workforce is the use of an accommodation barge, as has been used during major works at Sullom Voe Oil Terminal. Other options include private rented accommodation, temporary buildings and other methods.

4.4.3 Working hours

It is anticipated that works will tend to be concentrated in the months of approximately March to September due to the greater likelihood of adverse weather in the winter months, and short winter daylight hours. A typical working day would be 0700 to 1800 Monday to Friday, and 0700 to 1200 on a Saturday. However, to ensure that optimal use is made of fair weather windows and daylight, or at critical periods within the programme, it may be necessary to work outwith these hours and on Sundays. In particular it will be necessary to make use of low wind speed weather windows during turbine installation.

4.4.4 Construction infrastructure requirements

(a) **Site compounds**

It is proposed that there would be a central site construction compound, and satellite compounds (Figures 4.1.1 and 4.1.2). A typical layout for a satellite contractor's compound is illustrated in Figure 4.9. This would comprise portacabins for site offices, tool crates, welfare and maintenance and refuelling facilities. It is proposed to site the central construction compound at Sella Ness where there are existing areas of hard standing, and services.

(b) **Lay down areas**

It is proposed that a turbine lay down area would be established at Sella Ness, to provide space for the stockpiling of turbines. Additional hardcore laydown areas would be established at satellite site compounds, approximately 100 m by 100 m, with security fencing to suit. The purpose of these laydown areas is to provide logistical flexibility, a place to store minor plant items and materials, and to park construction plant.

(c) **Crane pads**

Hardstanding areas would be required adjacent to each turbine base to accommodate the cranes and their outriggers (Figure 4.10). These would comprise a hardcore fill. The final size, design and layout would be determined by the turbine supplier according to their preferred erection method.

(d) **Concrete batching plant**

It is likely that most of the concrete would be batched on-site, rather than delivered in readymix wagons. Aggregates can be delivered over a longer period than ready mixed concrete, and in larger weight quantities per vehicle load. The batching plants would comprise aggregate and cement hoppers, water bowsers and tanks, a mixer, and control cubicle. Aggregates would be stockpiled adjacent to the plant. The batching plant would probably be located at the satellite site compounds. The total amount of concrete required is likely to be in the region of 112,700m^3, requiring a total of 11,858 delivery vehicle movements.

4.4.5 Reinstatement

Reinstatement upon completion of construction would include:

- Areas disturbed by turbine foundation excavation
- Track batters
- Laydown areas
- Site compounds
- Borrow pits

The reinstatement strategy would be based upon reuse of materials which are removed and stockpiled during the construction process. It is proposed that crane pads and tracks would be retained in a condition such that they can be readily reused in the event of failure of a major turbine component, for regular maintenance during the life of the wind farm, and for disassembly of the turbines when the wind farm is decommissioned.

4.4.6 Construction traffic

Table 4.3 summarises the estimated construction traffic movements, which are explained in more detail in the Roads and Traffic Assessment (Chapter 15) and the Transport Statement (Appendix 15.1).

Table 4.3 Estimated construction traffic

Movement	Total number	Delivery days	Average per day*
Construction plant (in)	35	7	5
Construction plant (out)	35	7	5
Concrete - Aggregate	5,152	832	6
Concrete - Cement	1,554	832	2
Concrete - Sand	5,152	832	6
Cabling Sand	2,526	832	3
Steel reinforcement	36	36	1
Transformers	4	4	1
Control room equipment	5	5	1
Substation plant	10	10	1
Cable	54	54	1
Fuel	26	26	1
Turbine components	1500	300	5
Other	24	24	1
Total Vehicles	**16,113**		**39**

* Average per day does not include delivery of Construction Plant, the movements of which will be predominantly in the first and last weeks of the Construction Phase,.

4.5 OPERATION

The wind farm has been designed with an operational life of approximately 25 years. On a day-to-day basis the wind turbines would operate automatically, responding by means of anemometry equipment and control systems to changes in wind speed and direction. The windfarm would be connected to a remote control room, as well as an on-site building, from where output and key alarms would be monitored.

Each turbine would be subject to a routine maintenance programme involving a number of checks and changing of consumables, including oil changes. In addition there will be a requirement for unscheduled maintenance, which might vary between resetting alarms to major component changes requiring a crane. Typically maintenance traffic will be in the form of four wheel drive vehicles (for example Land Rovers) and vans.

In addition to the turbines, the substations and tracks will also require periodic maintenance.

The operational workforce is estimated to be about 50 individuals in Shetland.

4.6 DECOMMISSIONING

At the end of the operational period there are two potential options. The first will involve decommissioning the windfarm and the removal of the turbines and associated surface infrastructure and reinstatement of the site. All the above-ground infrastructure would be dismantled and removed, including turbines, anemometry masts, control buildings, substations and above-ground cables. Where practical, components would be recycled. This process would be relatively straightforward, involving no works off the hardstanding area.

In general it is preferable to leave buried structures and equipment such as foundations and cables *in situ*, thus minimising ground disturbance, and associated environmental impact. Subject to negotiations with the landowners and planning authority access tracks would either be left for use by the landowners or reinstated. In general, as for buried structures, it is environmentally preferable to leave tracks *in situ*, because over the course of 25 years they will have become integral to the hydraulic and peatland environment.

The second alternative is that an application could be made to develop a replacement wind farm on the site.

Whichever option is chosen, it will be subject to consultation with and approval by the relevant statutory bodies in existence at the time.

4.7 SAFETY MANAGEMENT

The project would be subject to the *Construction (Design and Management) Regulations (CDM) 2007.* These CDM regulations aim to ensure that safety is taken into account and then co-ordinated and managed effectively throughout all stages of a construction project from conception, design and planning through to the construction works and subsequent maintenance. Parties involved in the process have defined health and safety responsibilities.

As part of the CDM process, the detailed design would take account of relevant health and safety requirements and engineering standards.

During the operational phase, the operation and maintenance of the site would be managed in accordance with Viking Energy's Safety Rules.

4.8 DESIGN AND MANAGEMENT BEST PRACTICE

Subject to consent, and after appointment of contractors, relevant method statements would be supplied to the Planning Authority to define and agree specific design, construction, operation and, in due course, decommissioning details. However, a number of recommendations have emerged through the EIA process and these, along with general best practice standards, are identified and described in Appendix 4.4. These constitute commitments to best practice to be implemented (unless superseded by planning conditions), and have been taken into account in the assessment.

4.9 MITIGATION

The assessment has identified a range of site-specific mitigation measures which have been incorporated into the proposed planning, design, construction and operational stages of the development and which have been taken into account in determining the impacts and effects reported in the Environmental Statement. Full details of the mitigation measures are given in the relevant chapters, and are summarised in Appendix 20.1.

4.9.1 Habitat Management Plan

A Habitat Management Plan (HMP) has been developed as part of the EIA, and is presented in the Environmental Statement at Appendix 10.9. Apart from mitigating the effects of the wind farm, the HMP aims to make visible and measurable improvements to a number of elements of the Shetland natural environment which have been affected over the centuries by land management practices, especially sheep grazing.

The main aims of the HMP are as follows:

- Management of grazing at reduced levels;
- restoration of peatland hydrology and blanket bog integrity;
- lochan re-creation, restoration, repair and strengthening;
- restoration of natural watercourses;
- restoration of wet grassland habitats;
- restoration and creation of woodland habitats.

The techniques which will be used include:

- Management agreements with stakeholders including landowners, estate managers, crofters and commoners;
- damming small channels with peat or artificial materials (plastic, marine ply etc.);
- bank strengthening with relocated peat and aggregate;
- removal of artificial dams in main watercourses where they impede the movement of fish;
- planting woodland, and support of tree nursery projects.

A crucial aspect of the HMP is partnership working with local people, land managers and the statutory agencies. Full details of the Viking Energy proposals, including locations of proposed trial areas, work programmes, funding arrangements and monitoring requirements are shown at Appendix 10.9.

4.9.2 Peat Management Plan

Most of the wind farm will be constructed on peat. It is acknowledged that civil engineering on peat presents a number of challenges and potential hazards both to the engineering project and to the peatland environment. For this reason a Peat Management Plan has been prepared and is presented at Appendix 4.5.

4.10 DESIGN STRATEGY

The design of the development has taken into account several technical, commercial and environmental factors. The resultant design strategy is set out in the Design Statement for the proposed development (Appendix 4.6).

4.11 DESIGN ALTERNATIVES

4.11.1 Introduction

The design of the wind farm and ancillary works described in the preceding paragraphs has evolved through a series of design iterations which have sought to implement the design strategy. The following paragraphs describe the main alternatives considered during the design process.

Alternative technologies were discussed in Chapter 2, Background, and the selection of the Viking Wind Farm site was discussed in Chapter 3, Site Selection.

4.11.2 Turbine size

Turbine technology has evolved over recent years, with commercially available machines increasing in capacity from 500 kW to in excess of 5,000 kW (5 MW). Modern, larger capacity turbines are generally physically bigger than earlier smaller capacity machines, although the increase in physical size is proportionately much less than the increase in power output. In general there is a technical and commercial preference for larger machines.

However, the choice of size of turbine may also be influenced by other factors, in particular access constraints, and landscape and visual considerations. In the case of the latter, the question is whether fewer, larger turbines are more appropriate in a given landscape than a greater number of smaller turbines. This will of course vary according to the sensitivity of the local and regional landscape character to the scale and nature of the proposals. The advice of the consultant landscape architect was that in this instance, the local and regional landscape had the capacity to accommodate fewer, larger turbines.

4.11.3 Layout

The proposed turbine, track and anemometer layout which is assessed in this Environmental Statement has been arrived at through a design iteration process which has involved constant feedback from the environmental studies. The result is a layout which is now correct to within 50m (or 100m in exceptional cases), leaving scope for final micro-siting of elements within this distance at the time of construction, under the supervision of on-site Environmental Clerks of Works. The objective of such micrositing will generally be to avoid the best and most valuable ecological habitats, such as deep peat and actively growing blanket bog; and it will also be used where engineering conditions dictate a change.

Peat constraints

It was recognised at a very early stage that much of the proposed Viking Wind Farm would be built on land currently covered with peat and blanket bog. Before a preliminary layout was produced, therefore, an initial peat depth survey was undertaken to gain an understanding of the peat issues across the site and to inform the design process. Peat depths were sampled at 50m intervals along a selected number of transects, chosen to traverse different terrain types found across the site; these transects can be seen clearly in the series of Figures 14.9. In addition to peat probing data, for each location information was gathered on localised peat erosion features and the micro-location of probing (i.e. in gully; on hag; on stream bank etc.) Photographs were also taken at appropriate locations.

Using these site data, with digital terrain model (DTM), aerial photography and field observations, peat depths were extrapolated across the study area in peat depth ranges. Because of the size of the study area this extrapolation was carried out on a grid of 100m x 100m cells to produce a preliminary indicative peat depth map. Based on the findings, and where practicable, the preliminary layout located the various elements of the development away from identified areas of deep peat.

For further details of the peat survey work done prior to initial design please see Chapter 14.

Access track initial layout

Access track alignments were subject to particular study because of their importance as potential drainage pathways. Access tracks which follow existing drainage channels perpendicular to the contours can be assumed to be hydrologically neutral, since they will not alter the drainage pattern; tracks which closely follow the contours can be beneficial in terms of blanket bog conservation since they can act as barriers to drainage. Tracks which cross the contours obliquely, however, potentially can have an adverse impact on the hydrological system and are therefore used only where there is no alternative, and are subject to careful design and construction. The strategy which was adopted for the initial layout of the tracks is given at Appendix 4.1.

Access track adjusted layout

Following the production of the preliminary layout a second phase of peat probing was carried out along the route of the proposed site tracks and turbine locations. During the course of this site work it was found that some of the proposed tracks crossed exceptionally deep peat. Where possible these sections of track were realigned, taking into account other constraints such as ornithology and landscape. Recommendations were also made for the realignment of tracks to minimise the number of stream crossings.

Turbine locations adjusted layout

During the second phase of peat probing the preliminary turbine locations were probed at their centre point and at points around 25m from the centre on the major compass points (i.e. north, south, east and west). Deep peat (i.e. peat deeper than approximately 2.5m) was found at a number of these probing points. Where possible turbine locations were moved away from these areas before the layout was finalised. Further peat probing will be carried out at each of these locations at the detailed design and construction stage to allow micrositing of the turbines to the shallowest peat possible. For further details of peat probing please see Chapter 14, Soil and Water, and Appendix 14.1, Peat Stability.

The turbine layout in particular was subject to a number of revisions in the light of field survey and data gathered during the baseline studies phases. These studies revealed the extent, importance and sensitivity of the ornithological interests on the site, in particular the red-throated divers which nest in small lochan on the moorlands and commute to the sea to feed. Adjustments were made to the turbine layout, including leaving clear corridors, to minimise the effect on established diver flightlines. RSPB was extensively consulted during this phase and throughout the remaining project design stages.

The final set of fieldwork was undertaken from November 2008 to January 2009 following the design fix. This element of fieldwork investigated items such as final design stream crossing locations, peat depths on finalised sections of tracks, turbine locations and construction compounds. Ground condition surveys at representative locations were also undertaken to feed into peat stability process.

The design process for the Viking Wind Farm is set out in more detail in Appendix 4.7. This explains the factors that were taken into consideration in evolving the design, and in particular differentiates between those factors that were more important at a macro scale, and those that influenced the layout at a micro scale.

The initial design had 168 turbines, located in optimal positions for energy yield; indeed the first consultation draft of the layout had as many as 192 turbines. By considering information gathered during baseline studies (see Chapter 5), the number of turbines decreased over eight iterations to 150, with landscape, noise and bird factors creating macro constraints, and other factors, including visual composition from key settlements and proximity to newly discovered archaeological remains, influencing the layout at a more local level. The track layout was informed by a track design strategy which aimed to maintain or restore natural patterns of hydrology within the peatland.

4.12 CONCLUSION

The development of the proposed Viking Wind Farm has proceeded through a very complex process of design iterations. Initially these were technical in nature to ensure that the proposed locations for the turbines were suitable in terms of civil engineering constraints and wind resource. From then on the design iterations have taken into account mainly environmental considerations, while continuing to have regard to the civil engineering requirements. The final design layout comprises the optimum compromise between environmental and engineering requirements. Impacts on the natural and human environment are inevitable and are clearly acknowledged in this Environmental Statement. However, the proposed mitigation (in particular the Habitat Management Plan) seeks to remove or reduce these impacts to manageable proportions, and in some cases will deliver real benefits.